ENGINEERING NEWS
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AMERICAN RAILWAY JOURNAL.

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TABLE OF CONTENTS.

Engineering News of the Week 527, 532, 537

Technical Articles:

The Proposed Tower for the World's Columbian Exposition (*illustrated*) 528
The Value of a Water Power 529
Tests of Various Forms of Railway Spikes (*illustrated*) 530
Idiosyncracies of Chimney Draft 531
Compounds for Preventing Scale in Locomotive Boilers 531
The Indianapolis Cattle Guard Tests (*illustrated*) 532
European Rapid Transit Practice 533, 540
The Steel Skeleton Type of High Buildings (*illustrated*) 534
The Comparative Merits of Various Systems of Car Lighting. XII. (*illustrated*) 536
Standard Drainage Plans for the City of Mexico (*with insert*) 545
A Ten Months' Test of Compound Locomotives 545
Electric Lighting of Warships (*illustrated*) 546
The Gibbs' Steam Hose Coupler (*illustrated*) 550
The Glasgow Tramway System 550

Personals, New Publications, Society Proceedings 538, 539

Editorial Notes 540, 541

The Giving of Information to Correspondents—Lessons to Be Learned from the Late Water Famine in Brooklyn—The Report of the Interstate Commerce Commission—The Report of the Chief Inspector of Mines in Ohio—"The Engineer" on American Fast Trains—The Repair of Draw Bars on Freight Cars—The Limit in Weight of Heavy Guns.

Editorial:

The Growth of American Water-Works 541

Correspondence 543–545

On Some Criticisms of the Forth Bridge (*illustrated*)—N. Y. Dock Department Cement Tests—Selectmen as Engineers—Notes and Queries.

Construction News 551–554

Railways, City Transit, Highways, Bridges, Tunnels and Canals, Water-Works, Artesian Wells, Irrigation, Sewerage and Municipal, Electrical, Contracting, Proposals Open, Manufacturing and Technical.

THE NET EARNINGS OF RAILWAYS in the United States for the 9 months ending Sept. 30 show a very favorable increase over those of last year, as will be seen by the following figures compiled by the *Financial Chroncile*:

	1891.	1890.	P. c.
Trunk lines (12)	44,690,882	43,081,909	+ 3·73
Mid. Western (28)	11,514,121	11,083,095	+ 3·89
Northwestern (17)	22,023,325	20,585,171	+ 6·99
Southwestern (9)	13,220,582	13,167,279	+ 0·40
Pacific roads (21)	37,464,842	34,631,125	+ 8·18
Southern roads (32)	18,044,827	16,557,371	+ 8·98
Coal companies (14)	18,825,730	18,107,771	+ 3·96
Eastern & Mid. (35)	20 760,612	20,930,250	— 0·77
Mexican roads (2)	2,654,546	2,140,580	+ 24·01
Total.....(179 roads)	189,208,467	180,284,560	4·95

The Eastern and Middle group is the only one showing any decrease from last year's figures, and this is but small in amount. The Southern and Pacific groups show the largest gains.

THE NET EARNINGS OF 148 RAILWAYS for the month of September, according to the same authority, also show exceptionally large gains over the corresponding month of 1890. In amount the increase is much the largest for any month of the present year, but the per cent. increase (10.32) is smaller than for some other months. This increase is quite general, each group exhibiting better results than last year; but the heavy increases are shown by a few large systems only. Seventeen companies show increases of over $30,000 each, and an aggregate gain of $2,402,923, which is larger than the total gain for the 148 roads whose figures are given. The Northwestern coal companies and Southwestern groups show especially large gains, 24.05%, 20.15%, and 15.54% respectively.

A SMOKE CONSUMER was recently reported in use on about 25 Baltimore & Ohio locomotives, and it was said to be an invention of Superintendent of Motive Power HAZLEHURST. An investigation discloses the fact that about 30 locomotives running into Chicago have been equipped with the Hutchinson smoke consumer (described in our issue of April 4, 1891), which was put on to satisfy the Chicago smoke commission and not because in the opinion of the officers the device performs any very useful service.

THE DEPARTMENT of TRANSPORTATION EXHIBITS at the World's Columbian Exposition has received notice that the London & Northwestern Ry. will make an exhibit of its track, tools, equipment, &c. The chief of the department, Mr. WILLARD A. SMITH, invites correspondence with railway men and manufacturers and is especially desirous of obtaining information regarding relics of the early days of railways in this country.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Toledo, O., on the evening of Nov. 28, causing the death of 7 persons. In the outskirts of the city the Lake Shore & Michigan Southern Ry. passes underneath the Miami & Erie Canal by a 75-ft. tunnel. The eastbound vestibuled express passed through this tunnel, and was stopped by a signal just beyond it. A flagman started back immediately; but a Flint & Pere Marquette train, due only two minutes after the Lake Shore train, was following close behind, and the engineer saw the tail lights on the rear car and the brakeman's lantern at the same time, too late to stop. The engine telescoped the day coach on the rear of the vestibule train for half its length, and the steam from the boiler scalded many who would otherwise have escaped. There were no casualties except to passengers in this car, another evidence of the additional strength afforded by the vestibuling of cars when combined with a proper method of end framing.

A SERIOUS BRIDGE ACCIDENT occurred on the Orel-Graise Ry. in Russia, Nov. 24, causing the death of 26 persons. The breaking of a tire while the train was crossing a bridge over the Optoukha River precipitated five carriages over the parapet of the bridge (according to reports). The stream seems to have been deep enough to drown many not killed by the fall.

TWO FATAL ACCIDENTS to contractors' gangs have recently occurred in Washington. On the Yakima & Pacific Coast road, about 9½ miles from Chehalis, several laborers, working under Webster, Kelso & Dare, were buried by a land slide on Nov. 20. Five days later a gang of workmen repairing a washout on the main line of the Northern Pacific R. R., about 54 miles east of Tacoma, were caught by a land slide. Two were killed and six seriously injured. The road was blocked about 20 hours.

A DELAWARE-NEW YORK BAY CANAL ROUTE was proposed and explained by Prof. L. M. HAUPT, of the University of Pennsylvania, in a late lecture before the Franklin Institute. The feasibility of connecting the Delaware River at or near Philadelphia, with the Atlantic Ocean across New Jersey, has been long mooted, and various routes have been laid down. Prof. HAUPT's route is the latest surveyed. He proposes to follow the Delaware & Raritan Canal for 19 miles, from Bordentown to a point near Princeton, and then cut across a great loop in the present canal to the mouth of the Raritan River. The total length of the new canal would be 33.74 miles. For a canal 120 ft. wide at top and 90 ft. on the bottom, 20 ft. deep and a berme of 10 ft., the estimated cost for a 20 ft. channel from Philadelphia to New York is $12,500,000. He figures that the annual capacity of this canal would be 48,000,000 tons.

AN ELECTRICAL FREIGHT LOCOMOTIVE has been completed by the Thomson-Houston Co., at Lynn, Mass., for the use of the Whitin Machine Co. The locomotive is equipped with a powerful motor of the "G" type, communicating power from the armature to the rear axle by means of double reduction gearing, and from the rear to the forward axle by parallel rods. The power is to be conveyed over a trolley wire. The total weight of the locomotive is 43,000 lbs., and when indicating 100 HP. at the draw-bar, the speed is 5 miles per hour. This power is sufficient to haul about 300 tons on a level. The voltage on the locomotive is 500 volts; diameter of wheels, 42 ins.; speed reduction between armature and axle, 1 to 25; gage, 4 ft. 8½ ins.; wheel-base, 6 ft. 4 ins.; height of platform above rail, 4 ft. 2 ins; length at cow-catcher, 15 ft. 7¼ ins.; weight of motor, 5,400 lbs. It was designed by Mr. J. P. B. FISKE, and is intended to take the place of about 18 horses now used in hauling machinery at the works named. The speed is low, but sufficient for the purpose.

THE RAPID TRANSIT COMMISSION (New York) has obtained consents from over 41 out of a required 95 millions, but 34.6 of these millions represent city property and less than 7 millions private property, leaving consents from 44 millions of private property yet to be obtained. It is expected, however, that consents from the Sailors' Snug Harbor, Trinity Church and the Equitable Life Assurance Co., aggregating nearly 15 millions, will soon be received. The Court of Appeals has dismissed the claims of the "Central Underground" company, so that one minor obstacle is out of the way.

THE DRAINAGE TUNNEL CONTRACT for the City of Mexico, says *The Mexican Financier*, has been practically abandoned by the contractors, Messrs. Read & Campbell. They have notified the government of their inability to complete the work under existing arrangements, owing to the excessive quantity of water encountered in the shafts. The flow of 150 galls. per minute, as estimated at the time of the contract, sometimes exceeds 600 galls. in the same period.

A GUN LATHE, now being built by Wm. Sellers & Co., of Philadelphia, is said to be one of the largest and most powerful machines of its kind in existence. Is is for the Naval Gun Shops, at Washington, D. C., and is to be finished in January next. It is made of bronze, steel and cast iron and weighs 500,000 lbs. complete, and will be 133 ft. in length, 12 ft. high and 10½ ft. wide. It will bore a hole 16 ins. in diameter. The cost of this lathe is $76,000; and the same company is to build seven others of 14 in. capacity at an aggregate cost of $450,000. The face plate of the large lathe is made of cast iron and weighs 100,000 lbs. The bed of the lathe is 79 ft. 10¾ ins. long and 9 ft. wide, and the 6-in. feed screw is 62 ft. long.

AN ELECTRIC LETTER-STAMPER, showing to the minute the time of the receipt stamp on the letter, is being tried at the Washington post-office. The stamper is electrically connected with a clock and the time figures on the stamp are shifted each minute. The stamp gives a legend somewhat like the following: "Nov. 27. 9:14 A.M., '91." The old hand stamp was only changed each hour, or half hour.

FAST TIME, from Jersey City to Washington, D.C., was made on Nov. 28, by a "special" of three vestibuled Pullman cars carrying 68 passengers. The 227 miles was made in 251 minutes, including a stop of 5 minutes at Philadelphia to change engines, and 6 minutes lost in Baltimore because of a broken brake. The actual running time was then 50¾ miles per hour for the 227 miles. The runs, counting from the starting point, were: Jersey City to Newark, 8 miles in 6 minutes; to New Brunswick, 31 miles in 30 minutes; to Trenton, 56 miles in 53 minutes; and to Gray's Ferry, 91 miles in 93 minutes. From the last point to Washington the run was made in a pouring rain, with slippery track.

THE WHALE FISHING INTEREST, as summarized in Census Bulletin No. 123, has decreased about 41% since 1880. There are now 101 vessels in the trade, of which 27 hail from San Francisco, 4 from Connecticut, and 70 from Massachusetts. Only 36 of these vessels, however, fish in Atlantic Ocean waters; the remainder in the Pacific and 6 vessels) Indian Ocean. The decline of whale fishing is due more to scarcity of whales than to the introduction of mineral oil.

THE LONDON WATER SUPPLY from the River Thames, now amounts to 90,400,000 galls. per day, where it was only 35,387,000 galls. in 1858. The quantity of water abstracted from this river amounted in Aug., 1887, to 30.6% of the total flow, as an exceptional amount, and now represents a quantity calling for the selection of other sources. The Thames Valley can no longer be depended upon; and from the River Lea, in 1890, 72,800,000 galls. per day were already taken. After dealing with the pollution of the Thames and Lea valleys, Mr. A. R. BINNIE, the chief engineer of the London County Council, concurs with the recommendation of the Royal Commission on the Pollution of Rivers that the Thames should be abandoned, as early as possible, as a source of domestic water supply for London.

The Proposed Tower for the World's Columbian Exposition.

The prospects for the construction of a lofty tower at the World's Columbian Exposition have been alternately bright and gloomy, as the enthusiam of promoters or the conservatism of financiers, who counted the cost, alternately gained the upper hand. While projects for the exposition were still in an embryo stage, schemes innumerable were suggested, and were described by the newspapers, for structures intended to eclipse EIFFEL'S famous tower, either in height or in their power to draw the public to the exposition. Many of these proposed structures were as absurd in their mechanical design as their promoters were in their expectations of financial support; and their utter failure has led many to believe that there will be no attempt at the Columbian Exposition to rival the lofty and graceful structure on the Champs de Mars.

But at present we have the best of authority for stating that while the construction of the tower illustrated herewith is not absolutely assured, arrangements have progressed far enough to make its construction probable.

The designer of this tower is Mr. GEO. S. MORISON, who is perhaps the best known bridge engineer in the West, and whose reputation as a careful designer is such that no engineer, at least, would be afraid to sit on the topmost platform of the tower in the midst of the greatest gale that ever shook the Windy City.

We are indebted to Mr. MORISON'S courtesy for the accompanying drawings showing the general design of the tower, and for the following description of its details and plan of construction:

GENERAL DESCRIPTION.

The general arrangement of the tower and the arrangement of the accommodations are modeled from those of the Eiffel tower at Paris.

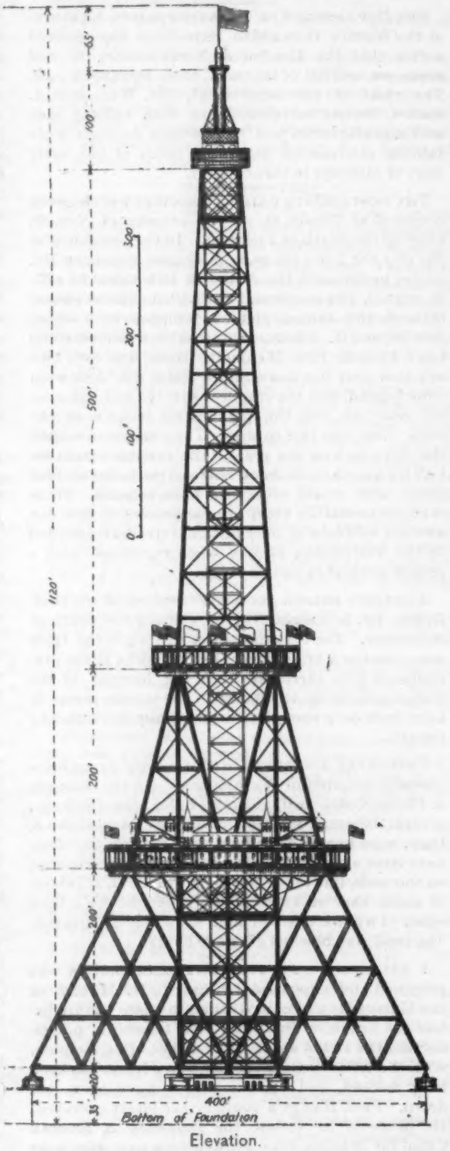
The base of the tower is made approximately two-fifths of the height. The first platform will be 200 ft. above the base, and will be occupied by promenades, restaurants and miscellaneous accommodations. It will be high enough to command the best view of the entire exposition grounds and buildings. The second platform is placed 200 ft. above the first platform, and is to be used in a similar manner, although it will be of less importance. Five hundred feet above the second platform is the lantern, which is the principal point for distant views and is surmounted by a lighthouse and flagstaff, the whole having a height of 165 ft.

While the general arrangement is derived from that of the Eiffel tower, the system of construction is necessarily of a very different character. The problem to be solved was to design a tower to be carried on the soft soil on which the city of Chicago is built. This soil is a fine sand, which carries large weights perfectly well, when they are properly distributed or supported, but has little power in itself to resist lateral thrusts. This rendered anything like the inclined supports of the Paris tower inadmissible, and also made it necessary to provide for the expansion of the metal of the tower in a manner which would not strain the foundations.

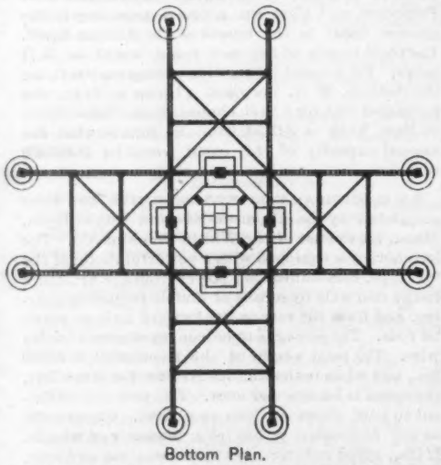
Besides consideration of the foundations, it was also necessary to design a tower which can be built in the shortest possible time and erected with a maximum speed. This made it necessary to confine the construction to straight lines and square angles, and this led to the selection of the plan adopted.

The upper shaft from the lantern down to the second platform is square, battering from 40 ft. square at the top to 100 ft. square at the base. The entire weight is carried by the four corner posts, which are stiffened by bracing in each of the four planes. The details are of much the same character as those of the high towers of an iron viaduct. It is the simplest possible form of construction as well as the strongest and most easily erected.

From the second platform to the first platform each of the four sides of the upper shaft is continued downward in a vertical plane, the four planes intersecting each other on vertical lines 100 ft. apart. Each of the four corner posts is therefore over one of the intersection lines of the planes, and the weight from each of the corner posts is distributed on four posts, two on each plane, these posts battering from each other with an inclination of 1 in 4. Hence the section of the tower between the first and second platforms consists of 16 posts, four in each of the four planes, the interior posts coming together at the base, and the arrangement of the four posts being



Elevation.



Bottom Plan.

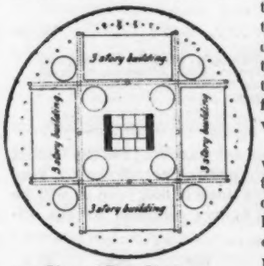
TOWER FOR THE WORLD'S COLUMBIAN EXPOSITION. GEO. S. MORISON, ENGINEER.

like a capital M, 200 ft. high and 200 ft. wide. Therefore the plan of the tower at the level of the first platform is cruciform, measuring 200 ft. in each direction and 100 ft. across each arm. The posts are braced together at intervals of 50 ft. in the four planes.

Below the first platform the weight from the 8 interior posts is carried directly to the foundation by vertical posts, while the weight from the exterior posts is carried down on the same principle that the weight from the four posts of the upper shaft is carried, that is, by two equally inclined posts from each point. To bring these posts together at the center, it was necessary to double the batter, making it one in two, instead of one in four. Each plane, therefore, of the lower 200 ft. of the tower becomes a capital M 200 ft. high and 400 ft. wide on the base, with a vertical member in the center. The members of this plane are stiffened by bracing placed every 50 ft. The base of the tower is then of cruciform section, each arm being 400 ft. long and 100 ft. wide.

The weights of the lantern and the several platforms are provided for at their several levels.

With this arrangement more than half the total weight of the tower is carried on four central points and is a fixed quantity. The remainder is carried on eight outlying piers, and varies with the wind pressure. The live load is distributed in the same way, but is of course a variable everywhere. The four central points of support are made fixed points and rest on piers which are united into one great foundation. The bearings on the outlying points are all made with expansion links which are able to resist both tension and compression; and the lines of motion of these links are made radial to the center of the tower, so that the expansion of the metal both longitudinally and transversely is provided for at the same time. The only expansion not provided for is that due to different temperatures in different parts of the lower horizontal plane, which is so small that it may be neglected. The entire structure is tied across the base and is complete in itself, the only stress transferred to the foundations being a vertical pressure.



Plan of First Platform.

The maximum weight thrown by the tower (with the complete estimated live load) on each of the four central points is 1,760 tons, or in round numbers 7,000 tons on the whole foundation. The maximum weight thrown on each of the eight outlying piers is 880 tons. This, however, is largely due to wind; the dead load alone thrown upon each of these piers is less than 300 tons.

If these weights are compared with the weights on the foundations of many of the tall buildings in Chicago, and especially under the grain elevators, which are the heaviest and oldest structures in the city, it will be seen that in spite of the immense size of the tower the foundations are a comparatively simple thing.

The weight of the structural portions of the tower above the masonry foundations is about 7,000 tons. To this is to be added 2,000 tons for the weights of floors and buildings, and 2,000 tons more for live load, making a total weight of 11,000 tons, of which less than one-fifth is variable.

A grain elevator of 1,000,000 bushels capacity (and there are much larger elevators than this in Chicago) weighs when full of grain at least 50,000 tons, of which more than one-half is variable. Besides this it exposes a large flat surface to the wind, and in all respects it is subject to much greater disturbing elements than the tower.

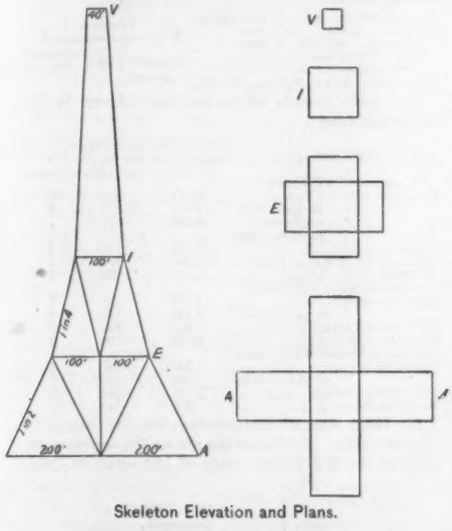
ACCOMMODATIONS.

The accommodations follow the same general arrangement, but have been materially increased from those of the Eiffel tower.

The first platform, which is supported on a cruciform section, is made circular, this shape being easily adapted to the shape of the support. The platform is 250 ft. in diameter. Around this platform runs a covered colonnade 15 ft. wide, the roof being supported by two lines of columns, and a substantial fence being placed between the columns of the ex-

terior row. This forms a continuous promenade unbroken by angles or any local features to check the movements of a crowd. Inside the circular promenade the platform is left uncovered, except where occupied by buildings. The spaces between the colonnade and the planes in which the structural members are, give room for four large buildings 45 ft. wide and 90 feet long. These buildings will be of light construction, 3 stories high, and will be occupied as restaurants; the lower stories will be only 7 ft. high and used as serving rooms. The second and third stories will each be 15 ft. high; and these, together with the flat roof, will furnish accommodations for chairs and tables. From each of these floors there will be an uninterrupted view, people on the first floor looking over those walking on the promenade, people on the second floor looking under the roof of the colonnade, and those on the roof looking over the roof of the colonnade. In the interior, besides the space occupied by the four large buildings, there will be room for a number of small buildings.

The lantern will be supported on the four corner columns, which are 40 ft. apart, the length of the



Skeleton Elevation and Plans.

diagonal being therefore about 57 ft. The lantern is made 60 ft. in diameter and two stories high, each story, however, to be but 7½ ft. high. This will give two rooms each having a circumference of 188 ft., which will be the lookouts of the tower, thus giving nearly 400 ft. of observation wall. The circular outside wall of each floor will be made solid for a height of about 3 ft. from the ground, the next 3½ ft. will be of plate glass, and above this will be a frieze, which will be graduated to mark the points of the compass, and the names of important places can be painted in the proper directions. This circle will be of such size that each degree will be more than 6 ins. long.

Above the two observation halls will be an open gallery to which the public will not be admitted. Here a small circular railway can be laid on which a powerful electric light can travel so as to produce variable effects of colored light. Within this track will be a smaller building containing rooms for special purposes. Above this small building a round shaft 12 ft. in diameter, made of boiler plate, will extend 60 ft.; this shaft will contain a spiral staircase leading to the highest platform of the tower, 1,020 ft. above the graded surface of the ground. Above this platform will be a lighthouse surmounted by a flagstaff. The total height from the ground to the top of the flagstaff will be 1,086 ft., and from the bottom of the foundation to the top of the flagstaff 1,120 ft.

Within the main structure is to be built a secondary structure, 36 ft. square and of uniform size throughout, extending from the foundation to the lantern. This structure is to hold the elevators. It is divided into 9 shafts of approximately equal size, 8 of which will be occupied by the elevator cars, and the ninth at the centre will hold the machinery. Each elevator car will have an area of 100 sq. ft., and be capable of carrying 50 people. The four corner cars will run to the first platform, two of the others will run to the second platform, stopping at the first, and the other two will run to the top of the tower. There will be separate entrances at the base to the three different classes of cars, so that no confusion can result.

A double staircase will be built around the elevator shafts from the foundation to the first platform, and a single staircase from the first to the second platform.

CONSTRUCTION.

Foundations.—The foundation work will comprise eight outlying piers supporting the exterior bearings of the tower, and the central pier, which supports the center bearing. These foundations will be concrete piers resting on piles. The weight per pile will be limited to from 10 to 15 tons, according to observations to be made when work is actually begun. These weights are without any allowance for the bearing on the ground surface between the piles; if the piles were entirely omitted, the weight on the surface would be from 1¼ to 1¾ tons per sq. ft.

The concrete foundation will begin 2 ft. below mean water in Lake Michigan, and the piles will extend up 3 ft. into the matrix of concrete. All concrete will be of first class quality, made with Portland cement. The central pier will contain 7,500 cu. yds. of concrete and will be supported on 1,000 piles. Each of the outlying piers will contain 700 cu. yds. of concrete and will be supported by 185 piles.

Above the concrete foundation, which will be about level with the graded surface of the ground, will be built separate piers, one on each of the outlying foundations and four on the central foundation. These piers will be of limestone with heartings of Portland cement concrete, the piers on the central foundation being 30 ft. square and 14 ft. high, and those on each of the outlying foundations 20 ft. in diameter and 11 ft. high. The total amount of masonry and concrete in all the foundations is somewhat more than 15,000 cu. yds.

Structural Metal.—The tower will be built of mild steel and of wrought iron, the latter being used only in the lighter members. The principal columns are of square box section, fitted with manholes and interior ladders for purposes of inspection and convenience of workmen. These columns below the second platform will be 40 ins. square, and above the second platform they will taper, decreasing from 40 ins. at the base to 16 ins. at the lantern. All the interior columns will be built of plates and angles with open laced sides. All bracing and stiffening members will have riveted connections so that nothing can get loose; the compression members are generally square, made of four angles at the corners and with all four sides laced; the tension members are made of four bulb angles, placed in pairs, back to back, with a single line of lacing.

The weights on all the floors are taken at 100 lbs. per sq. ft., of which one half is treated as live load. The weights of the tower used in the calculations are the actual weights of the metal. A wind pressure of 50 lbs. per sq. ft. on the entire structure is provided for, and a wind pressure of 80 lbs. per sq. ft. on the lantern is provided for in all members above the second platform.

With these conditions the strains are limited to 14,000 lbs. per sq. in. on square box columns with a maximum unsupported length of 16 times the width, and these strains are reduced for longer columns, or when thin metal is used in the plates. Where any member is subject to both tension and compression, the sum of the two strains is used in determining the section. The interior elevator shaft will be of the same character of material, and will rest directly on the central foundation.

The entire structure will be incombustible, the floors of the platforms being covered with asphalt or cement concrete, and no wood being used anywhere for structural purposes.

The Value of a Water Power.

In this paper, read by Mr. CHAS. P. MAIN, at the meeting last of the American Society of Mechanical Engineers, the author contends for a more accurate determination of the value of water power than is usually made in case of the condemnation of a water power or water privilege and its appraisal. Mr. MAIN is Superintendent of the Lower Pacific Mills at Lawrence, Mass., and has already presented some valuable papers on the cost of steam and of water power before the society, one of which, read at the last New York meeting, will be found in our issue of Jan. 24, 1891.

The paper opens by criticizing the custom of estimating the value of a water power, as represented by the sum of money which, when put at interest, would maintain a steam plant of the same power at the same place. Probably there is no place where this reasoning would hold absolutely good. In the first place it is plain that a water power may be of more value for one kind of business than another. Passing this by, however, the value of a water power depends upon:

1. The quantity of water, the fall and the uniformity of flow, both during the year and during a succession of years. (*a*) If the fall is low, the first cost per horse power of plant will be very much more than that for a high head. (*b*) The effect of variable flow on value is difficult to determine; but the author is firmly convinced that there are many concerns using water power so variable as to require an auxiliary steam plant as large as the water power plant, which, if they were to begin anew, would profit by using steam alone. It must be remembered that the cost of maintenance of a double plant has to be added to the running expenses where two kinds of power are used. As for streams so variable that part of the plant must shut down for a portion of the year, they are of very little value for industries employing any considerable amount of labor.

2. The value of a water power depends largely on its location, increasing as its remoteness from transportation lines increases the cost of fuel which could furnish steam power; but decreasing as the same remoteness increases freight on raw material and finished products.

3. The value depends on the social and sanitary conditions which may cause good operatives to locate and remain in the place.

4. Almost every business requires steam for other purposes than power; and it can usually be as well used after exhausting from an engine. Therefore the consumption of very little more fuel is necessary to run the engine that would be required for the heating in any event.

The author then discusses the method of estimating the value of an undeveloped water power. The following are the essential points to be considered:

a. Quantity of water during a dry year.

b. Uniformity of flow during the year, considering the storage capacity, natural and artificial.

c. Head of fall.

d. Conditions which fix the expense of building dam and canal, and flowage of land.

e. Conditions which affect the cost of foundations for buildings.

f. Geological conditions which determine the permanency of the falls.

g. Freight charges for fuel, supplies, raw materials, and finished product.

h. How much low-pressure steam can be used for heating purposes, and whether exhaust steam can be used for those purposes.

i. Is water needed for other purposes than power and in what quantities.

j. The social and sanitary conditions which make it possible to procure and keep good help.

k. The greater uniformity of speed with steam than with water power.

The author then illustrates his method by supposing the constant portion of the Lawrence water power, about 10,000 HP., to be undeveloped. We quote from his paper as follows:

There is no question but what the business which is located along the Merrimac in Lawrence, which is the very business for which the development was made, could be equally well carried on in some other location where fuel and transportation are cheaper than in Lawrence. Let us consider it located where coal can be obtained at $3 per ton.

The amount of heat required per horse power would vary with different kinds of business; but taking it for an average plain cotton mill, there is an amount of steam required for heating and slashing, which is equivalent to about 25 % of steam exhausted from the high pressure cylinder of a compound engine of the power required to run that mill, the steam to be taken from the receiver; supposing this power produced by steam with plants averaging 500 HP. each.

The coal consumption per horse power per hour for a compound engine is taken at 1¾ lbs. per hour, when no steam is taken from the receiver for heating purposes. The gross consumption when 25% is taken from the reservoir is 2.06 lbs.

75% of the steam is used as in a compound engine at 1.75 lbs =	1.31 lbs.
25% of the steam is used as in a high pressure engine at 3.00 lbs. =	.75 "
	2.06

GROSS CONSUMPTION.

The running expenses per horse power per year are as follows:

2.06 lbs. coal per hour = 21.115 lbs. for 10¼ hours or one day = 6,503.42lbs for 308 days, which, at $3 per long ton=	$8.71
Attendance of boilers, one man @ $2 and one man @ $1.45 =	2.00
Attendance of engine, one man @ $3.50=	2.16
Oil, waste and supplies =	.80
The cost of such a steam plant, in New England and vicinity, of 500 HP. is about $65 per HP. Taking the fixed expenses as 4% on engine, 5% on boilers, and 2% on other portions, repairs at 2%, interest at 5%, taxes at 1½ % on ¾ cost, and insurance at ½ % on exposed portion, the total average per cent. is about 12½%, or $65 × .12½ =	8.13
Gross cost of power and low-pressure steam per horse power,	$21.80

At Lawrence the cost of dam was $250,000. The cost of North canal about $250,000, and of South canal about $150,000,* or a total sum of $350,000 or about $65 per HP. The cost per horse power of wheel plant from canal to river is about $45 per HP. of plant, or about $65 per HP. used, the additional $20 being caused by making the plant large enough to compensate for nearly all of the fluctuation of power due to rise and fall of river. The total cost per horse power of developed plant is then about $130 per HP.

The dam at Lawrence has a record which probably is unequaled elsewhere. It has shown no signs of weakness or leakage, and has required no work to be done on it since its completion. This cannot be said in most cases. The canals, of course, do not require renewals, but do require repairs. The gates, locks, &c., require renewals. Several portions of the plant from canal to river require renewals at intervals. I have placed the depreciation on the whole plant at 2%, which, perhaps, is high for Lawrence, but none too high for the average plant; repairs at 1 %; interest at 5 %; taxes and insurance at 1%, or a total of 9 %.

Fixed expenses per horse power $130 × .09 =	$11.70
Running " " " " (Estimated)	2.00
	$13.70

The amount of steam required for heating purposes we have said to be about 25% of the total amount used; but in winter months the consumption is at least one and one-half times the average consumption, or 37½%. It is therefore necessary to have a boiler plant of about 37½% the size of the ones previously considered with the steam plant, costing about $20 × .375 = $7.50 per horse power of power used if the source of power is water.

The expense of running this boiler plant is as follows:

Fixed expenses at 12½%. $7.50 × .125 =	$0.94
2.06 × .25 = .515 lbs. coal per hour average consumption per horse power. .515 × 10.25 × 308 = 1,626 lbs. per year, at $4.50 per ton =	3.26
One man at $2 per day =	1.23
	$5.43

A plant of minimum size, used for heating buildings alone, would be about 20% of the size required for power. $20 × .20 = $4 per horse power of power.

The fixed expenses would be $4 × .125=	$0.50
Coal, 0·5 ton per horse-power per year at $4.50 per ton	2.25
Attendance, one man at $2.00 per day for 150 days..	.60
	$3 35

The effect of item *g* (freight charges on raw materials and product) can be estimated approximately by knowing the difference in charges for freight between our proposed location on the river and elsewhere equally suitable in other respects.

In an ordinary plain cotton mill, of average numbers about 30, the weight for raw material brought to the mill would be about 40 tons per 1,000 spindles. The outgoing freight would be about 30 tons of finished product and 5 tons of waste. Calling all other supplies, &c., 5 tons, we have a total weight moved of about 80 tons. Taking the power required as 20 HP. per 1,000 spindles, the amount of freight per horse-power would equal 80 ÷ 20 = 4.00 tons per year. If a saving of 50 cts. per ton can be made by locating nearer the base of supplies and markets, the saving per horse-power would be $2. per year. This amount of saving should either be deducted from the cost of steam power, or added to the cost of water power in getting their comparative value.

There is another portion of item *g* which cannot be expressed in money, and that is the advantage of nearness to markets for sale of goods.

* See reports on the Water-power of the United States part I. page 25, Tenth census of the United States.

Item *i*. If water is required in large quantities for other purposes than power, for washing, &c, an estimate should be made of the cost of providing this away from the stream, and this amount deducted from the cost of water power or added to the cost of steam power. Let us assume that in the case under consideration the cost would be $2 per HP. per year.

Considering all the other items of equal value in each case we should have the total costs as follows:

Steam power as given...	$21.80
Water " $13.70 + 5.43 + 2.00 − 2.00 =	19.13
Difference in favor of water power...	$2.67

$2 67 × 10,000 = $26,700 per year saving on 10,000 HP.

Now it is fair to say that the value of this constant power is a sum of money which when put at interest will produce the saving; or if 6 % is a fair interest to receive on money thus invested the value would be $26,700 ÷ .06 = $445,000.

I do not want it understood that this is my estimate of the value of that portion of the water power at Lawrence which is constant, for certain premises have been assumed for illustration simply without a knowledge of all the truth.

If there are no other considerations than power it will be profitable to develop a power so long as the conditions fixing the cost of construction and running expense do not bring the fixed and running expense so high that the total cost per horse-power for water power will be equal to that of steam power. When that point is exceeded it would be folly to develop the water power.

The cost per horse-power for the dam would not increase in the inverse ratio as the head, but the cost of canal and that portion of plant from canal to river would increase very nearly in that ratio. So that if at 28 ft. head the cost of plant is $138 per HP., at 10 ft. head the cost would be nearly 2·8 times as much, or say $350. The fixed expense in this would be $350 × .09 = $31.50, and running expense say $5.. making a total of $36.50 per HP. per year, which is far beyond our cost given for steam power.

The author gives also the following example of the method of estimating the value of a variable undeveloped power:

We must here consider:

a. The maximum, minimum and average quantity of water and length of time when there is no water.

b. All the other items which entered into the value of a uniform power.

c. Necessity in nearly all cases for a supplementary steam plant.

The quantities and falls at different times determine the power. If there is liability to excessive rises in the river, the head is diminished by back-water and the power reduced. If the quantity of water is reduced below its normal flow, the power is reduced and ceases altogether when the flow ceases. If the variation causes many days of complete or partial shut-downs, the power will be of no value for most kinds of business unless supplemented by steam power; and if the total lack of water is for many days, the steam plant must be of the same power as the water power used.

We should then have the expense of maintenance of two plants and the running of each a portion of the time.

Let us consider again a power of 500 HP., or several plants of 500 HP. each, with a head of 28 ft., costing about $130 per horse power of water plant. To this add $65, the cost of a steam plant, thus making the total cost of plant $195 per horse power.

It will make but little difference about the wear and tear whether the plants are run a portion or all of the time. The fixed expenses are:

On water power plant, $130 × .09 =	$11.70
On steam power plant, $65 × .125 =	8.125
On both power plants	$19.825
The running expense for water power is, say	2.00
And for steam power, according to length of run, cost of coal, &c	
If coal is $4.50 per ton and the engine is run for two months with its proper load all the time, the cost of coal will equal for that time about	1.91
Attendance for boilers and engine for two months..	.70
Having the boiler plant already in, the fixed expenses do not have again to be added for heating purposes, but the running expense does. It is usually the case that low water occurs in the summer and fall, when no heating is required of buildings. The least amount required for this purpose we have seen to be $2.25 for coal and $.60 for attendance =	2.85
Total cost for power and heat	$27.285

The author sums up the method of estimating the value of a developed water power as follows:

If it can be run cheaper than steam, the value is that of the power, plus the cost of plant, less depreciation. If it cannot be run as cheaply as steam, considering its cost, &c., the value of the power itself is nothing, but the value of the plant is such a sum as could be paid for it new, which would bring the total cost of running down to the cost of steam power, less depreciation. That is, it is worth just what can be gotten out of the plant and no more.

It will be seen that on the whole the author's arguments tend to show that water power is far less valuable than the general public and even engineers ordinarily suppose. One point, however, he omits from his discussion, the great increase in the value of water power which follows the adaptation of electricity or perhaps compressed air to transmit its energy to some point where it may be conveniently used. This has already led to the development of many water powers which have heretofore been idle, and it is doubtless destined to bring very many more of them into service. Certainly enough has been done in this direction to justify the owner of an undeveloped power, in some locations, in considering its value increased over what it was, say five years ago, and to justify him also in demanding some recognition of such increase in value in the case of condemnation proceedings.

Tests of Various Forms of Railway Spikes.

A graduating thesis by Mr. A. J. Cox, '91, University of Iowa, published in *The Transit*, of that institution, gives some interesting experiments on the above subject, the spikes and woods tested having been:

Common spike, 5½ × ⅜ in.. 8.3 oz.	Tested in: White oak seasoned.
Bayonet spike, 5½ ins. grooved portion 4 ins. long, triangular section, back concave.... 6.8 oz.	" " unseasoned
Hill curved spike, 5⅞ ins... 9¼ oz.	White cedar unseasoned.

The main results of the tests are shown in the following table:

Kind of tie and spike.	Maximum Resistance in lbs.	Resistance per oz. of weight.	No. of tests.
In seasoned white oak:			
Common spike, 8.3 oz	5,514	664	20
" " in ⅛-in. hole.	4,993	595	9
" " redrawn.....	4,490	537	1
" " in ⅛ in. hole, redrawn.....	3,240	390	2
Hill curved spike, 9.25 oz.....	5,842	632	4
Bayonet spike, 6.8 oz	6,350	934	3
In unseasoned white oak:			
Common spike.....	4,706	567	7
" " in ⅛-in. hole..	6,140	740	3
Hill curved spike.....	5,130	555	5
Bayonet spike	5,334	784	3
In unseasoned white cedar:			
Common spike.....	1,140	137	2
" " in ⅛-in. hole..	1,400	169	2
Hill curved spike.....	1,775	192	2
Bayonet spike.....	955	140	1

The range was, as must always be the case, very considerable. The following shows the separate results of the 20 different tests of the common spike

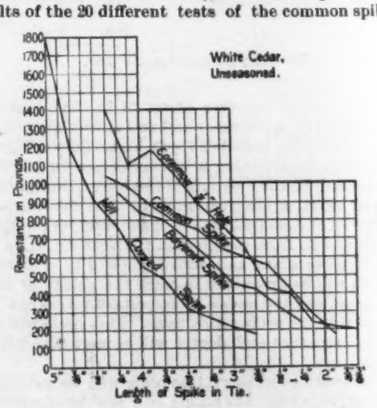


Fig. 1.

nearly driven in seasoned white oak, which were made on 4 different ties. We add the averages for each tie to the table:

	Tie 1.	Tie 2.	Tie 3.	Tie 4.
Maximum Resistances to extraction	5,200	5,800	3,120*	7,200
	7,300	6,520	3,550	6,030
	5,100	5,280	4,500	6,500
	6,000	.....	4,300	7,700
	6,870	.....	3,500	.....
	4,950	.....	4,850	.....
	.....	.....	3,820	.....
Average, each tie	5.914	5,887	4,243 (mean	6,857 5,514)
Maximum "	7,300	6,520	5,120	7,700
Minimum "	4,950	5,280	3,820	6,030

It will be observed that (with one exception apparently due to difference in number of tests), the order of the ties in respect to the mean resistance is their order in respect to maximum and minimum, indicating that the difference in different ties is a more important factor than difference in driving or other conditions.

The above tests were all for newly driven spikes. The resistance to extraction was shown to decrease

quite rapidly with time by the following tests of 12 spikes in the same tie (tie No. 1 above):

	No. Tests.	Mean resist. Lbs.	Max.	Min.
Spikes newly driven.....	6	5,914	7,360	4,950
Driven 9 days	3	4,483	4,500	4,450
Driven 11 days.....	3	4,803	5,000	4,600

Fig. 1 illustrates the behavior of the several spikes tested in unseasoned white cedar. It will be observed that, although the curved spike has a greater initial resistance, because ⅝ in. longer, yet for equal lengths in the tie the common spike shows a greater resistance than either the curved or the bayonet. It will also be observed that boring the tie for the spike is highly beneficial in this soft wood, though other tests show the reverse to be the case in oak.

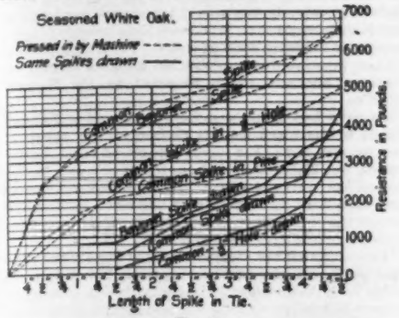


Fig. 2.

The results in oak, as shown in Fig. 2, are much more favorable to the bayonet spike, which makes a very creditable showing, even without considering its decided difference in weight.

The following tests of lag screws in various woods were also made:

Kind of wood.	Size screw.	Size hole bored.	Length in tie.	Max. resist. lbs.	No. tests.
Seasoned white oak.....	⅝ in.	½ in.	4½ in.	8,037	3
Seasoned white oak.....	⅞ "	⅞ "	3 "	6,480	1
Seasoned white oak.....	½ "	⅝ "	4½ "	8,780	2
Yellow pine stick.....	⅝ "	½ "	4 "	3,800	2
White cedar, unseasoned.....	⅝ "	½ "	4 "	3,405	2

In figuring area for lag screws, the surface of a cylinder whose diameter is equal to that of the screw was taken. The length of the screw part in each case was 4 ins.

The Idiosyncrasies of Chimney Draft.*

One of the favorite themes of the compiler of formulas is that of chimney draft, and it becomes an easy matter for a mathematician to tell just what draft a certain chimney will give. The poor engineer who must design and use these chimneys finds it a very complex problem, and there are little things which enter into it which the mathematician thinks are of no account.

We are told that it makes no difference if the inside flue stops somewhere in the chimney or is continued to the top; that it may be either larger or smaller at the top without detriment.

The question will naturally arise as to the effect on the velocity of a current of air or gas if it is suddenly enlarged, as it must enlarge when the inside flue is shorter than the chimney itself, as it must be in a measure affected the same as when issuing from the top. We are also told that the draft cannot be increased after the temperature arrives at 600°; and if we wish a draft of 0.85 in. of water, we must have a chimney or stack about 116 ft. high, although this is attained in a stack 90 ft. high; while with that height (90 ft.) .75 to .80 in. is a common thing where the temperature of gases entering the chimney is 800°.

By some claiming to be authorities it is urged that a chimney must grow gradually larger from bottom to top.

With a view of getting some light on the subject, the writer has taken the draft from a number of chimneys working under various conditions, and presents the results for the consideration of the society.

The draft on all these was taken on a clear morning, with temperature of air at 60° to 65°.

To make easier the comparison of the various chimneys measured by the author, we have arranged the data which he presents of each chimney in the table herewith given. Of chimney No. 4, he says it is a mystery why it falls behind the others doing the same work, as the only different thing is the stopped-off flue. However, the chimney was built by the lowest bidder; and when the draft was taken cracks had appeared, which may account in a measure for the poor results.

The temperature from casting furnaces may be taken as from 700° to 800°, and annealing furnaces at 700°. It would seem from the above that a manufacturer who was building chimneys for high temperatures would not need to build as high as he would for his boiler chimneys.

If it shall be proved that forced draft for boilers is the more economical, there would seem to be no good reason for building chimneys over 100 ft. high.

This is important, as one chimney for casting was built 200 ft. high, as it was claimed that better draft was needed for casting furnaces than for boilers, and it was supposed that the height governed the intensity of the draft.

The length, shape and size of flue has much to do with draft in the furnace, but all the above were taken from the base of the chimneys.

* A paper by W. E. CRANE, Waterbury, Conn., read at the New York meeting of the American Society of Mechanical Engineers.

Compounds for Preventing Scale in Locomotive Boilers.

At the October meeting of the Western Railway Club Mr. J. N. BARR described the excellent results which are being obtained on the Chicago, Milwaukee & St. Paul in the prevention of scale in the locomotive boilers by the use of an alkaline compound. The compound consists of 3,750 galls. of water, 2,600 lbs. of 70% caustic soda and 1,600 lbs. of 58% soda ash. This makes a nearly saturated solution, which costs, barreled at the roundhouse, about 4 cts. per gall.

On the division between Milwaukee and Madison the water supply contains from 1 to 4½ lbs. of incrusting solids per 1,000 galls., principally calcium carbonate and sulphate and magnesium sulphate. The amount of compound necessary to prevent the incrustation is 1½ to 7 pints per 1,000 galls of water. This is really only one-fourth of the quantity needed for chemical combination, but the action of the compound is regenerative. The soda ash (sodium carbonate) extracts carbonic acid from the carbonates of lime and magnesia and precipitates them in a granular form. The bicarbonate of soda thus formed, however, loses its carbonic acid by the heat, and is again changed to the active carbonate form. Theoretically this action might continue indefinitely; but on account of the loss by blowing off and the presence of other impurities in the water, it is found that the soda ash will precipitate only about four times the theoretical quantity.

On the run between Madison and Milwaukee, 96 miles, passenger engines use a little over 4,000 galls. of water; and 1 gall. of the compound is put in the tender at the roundhouse before starting on each trip. Scaling is entirely prevented. One engine on this run has made 122,000 miles to Oct. 1, 1891, and a careful inspection of the boiler shows that it is as clean to-day as the first week it went into service; and no repairs whatever have been made on firebox or flues.

This compound precipitates the impurities in a granular form, and careful attention must be paid to washing out the precipitate. The practice is to change the water every 600 miles and wash out the boiler every 1,200 miles, using the blow-off cocks also whenever there is any indication of foaming, which seems to be caused by the precipitate in the water, but not by the alkali itself.

The use of this compound is being steadily extended to other divisions of the road, and with encouraging results. In its application, however, great care is taken to get the right amount. An analysis of the water is made and the amount of compound necessary is calculated on the assumption that it regenerates four times, as explained above. In practice somewhat less than this is tried at first, and the amount is increased if it is found that any scale is being formed. On the Chicago & Milwaukee passenger runs about 11,000 galls. of water are used, and the compound required is about 2½ qts. per 1,000 galls. It has been found impracticable to rely on the engine driver to apply the purge from cans with proper accuracy, and the amount for each run is therefore carefully determined, and it is put in at the roundhouse before starting.

It will be noted that the waters treated are by no means the worst found in the West. It is intended, however, to try the compound on some of the worst waters in use, although no very satisfactory results are expected.

In the discussion on this paper at the meeting on Nov. 17 Mr. WM. FORSYTH suggested that the loss of heat through foaming and blowing off might more than offset the advantage due to the absence of scale and the consequent increased evaporation from the heating surfaces. He questioned whether better results would not be secured in water purification if the process was applied to the water in the tanks at the water stations.

Mr. GIBBS said this was no doubt the ideal method of purification, but he questioned whether it could be successfully carried out in practice. He had made many experiments in this direction, beginning with the Clark process, precipitating the lime salts with milk of lime; but to get exactly the right quantity of compound was too difficult a task. The mechanical purifiers, while well enough, perhaps, for stationary boilers, he did not believe could be successful on a locomotive boiler, where the circulation was so rapid that the sediment would be carried out of the purifier. As to foaming, while this is chiefly due to the sediment in the water, it is also due to some extent to the alkali in the water, so it would not be wholly stopped if the water were treated in the stationary tanks.

Mr. MCNAUGHTON had had two locomotives with mechanical purifiers, one Field and one Barnes, run-

OBSERVED DRAFT OF VARIOUS CHIMNEYS.

No. of chimney.	Height of chimney, Feet.	Height of flue, Feet.	Size and shape of flue.	Kind of furnaces and number.	Area of grate surface, Sq. ft.	Coal burned per sq. ft. of grate per hour, lbs.	Temperature of gases.	Draft, ins. of water.	Remarks.
1	130	100	round, 4 ft. diam.	2 boilers*	76½	14	340°	0.55	*1 Babcock & Wilcox, 1 Harrison.
2	90	90	28 ins. square	15 casting furnaces	19.5	25	775°	0 77	
3	78	78	28 ins. square	15 casting furnaces	19.5	19	....*	0.64	*not taken but inside ladder burned out.
4	90	75	27 ins. square	20 casting furnaces	26	17	....*	0.46	* " " bottom of chimney at a dull red heat
4	Same chimney with 10 furnaces and damper on others closed tight				.. ..	..	....	0.50	
4	Same chimney with damper open 3 × 18 ins. and 10 furnaces				....	..	....	0 40	
5	148	148	48 ins. square	{ 2 boilers* 59 casting furnaces	99.5 76.7	14 25	350° ....*	0.70 to 0.75	{ *Babcock & Wilcox boilers. *average combined temp. probably 500° to 600.
6	68	an iron stack,	round*	3 Harrison boilers	51	12	....	0.35	*3½ ft. diam. at bottom, 4 ft. at top.
	The location of these boilers being changed, the stack has been reset, large end down. With two of the boilers running the draft is practically the same as before, though the gage shows 0.01 in. to 0.02 better since the change.								
7	95	95	48 ins. square	56 casting furnaces	99.50	18	....	0.75	
8	60	60	18 ins. square	2 annealing furnaces	27.	1 cord chestnut wood in 9 hrs.		0.40	
9*	90	90	30 ins diam.	16 casting furnaces	28.3	18	.. ..	0.85	*an iron stack
10	80		Not known	annealing	....	..	....	0.50	
11	135	135	48 × 50 ins.	boilers and annealing	....	..	Not over 400°	0.55	
12	60		Not known	annealing	....	..	....	0.40	

ning on water similar to that used by the Chicago, Milwaukee & St. Paul, and the boilers show thus far no scale formation. Ordinary boilers are washed out every 1,100 miles of run, but these boilers are washed only once in 5,000 miles of run.

Mr. SMITH used the Smith compound. The cost is about 40 cts. per gall. One gallon was used whenever the boiler was washed out (about once in 1,000 miles). It seems to prevent scale and will even remove it when once formed. He had tried mechanical purifiers, but had so much difficulty with lime blocking the interior surfaces of the pipes that he discarded them.

Mr. HERR said the compound used on the Chicago, Milwaukee & St. Paul greatly decreased the work of cleaning flues. It is exceptional now to call in a boiler maker at the Milwaukee roundhouse (where 120 engines are handled) to calk flues, where a year ago two or three were at work nearly all the time. This compound will remove scale after it has formed even as thick as ¼ in. It seems to attack the scale on the hottest sheets first. He had proved by experiment that the foaming was due to the fine sediment thrown down and not to the alkali in the water.

Mr. LEWIS had tried many compounds, and believed that chemical purification of water was a hopeless task. Mr. BARR'S figures show that he is using about three-fourths of a grain of chemicals per gallon of water, while the water contains 7 to 25 grains to the gallon of impurities. This looks like sending a pigmy to do the work of a giant. Perhaps a good share of the benefit which Mr. BARR finds is obtained by the frequent blowing off instead of by the chemicals. For the past year or more Mr. LEWIS had used coal oil with very good results. When the boiler is emptied, just before it is to be washed out, a gallon of coal oil is poured in; and as the water rises in the boiler, the coal oil floating on the surface is deposited on the surface of the iron. It penetrates between the scale and the iron and the scale cracks off when the boiler is heated.

Mr. GIBBS said the use of coal oil was open to some objections. Experience shows that a film of oil on a plate is liable to cause serious overheating of that plate. Boiler compounds are in general disfavor with master mechanics; but the reason is that they are not used intelligently. Hardly any two waters are alike in composition, and yet boiler compounds are sold as applicable to all waters. It is true the water used on the Chicago, Milwaukee & St. Paul is not as bad as some roads have to use, but it is as bad as that which most roads have to do with; and experience has shown that this water can be purified and all the evils of scale avoided at a reasonable cost. Many vegetable compounds have been used for scale prevention—potatoes, molasses, &c.—and they all act in the same way, their decomposition causes the breaking up of the scale.

RIVER WATER AND SEWAGE CONTAMINATION has been reported upon by Prof. PETTENKOFER, of Munich, by order of the German government. Munich, with $280,000 inhabitants, discharges into the Isar 40,000 lbs. weight of sewage daily, or 15,000,000 lbs. per year. At Ismanig, 3½ miles below the sewer outlet, he could find no trace of sewage by analysis. Prof. PRAUSNITZ found 198,000 bacteria per cu. cm. at the mouth of the Munich sewer, and this was reduced to 15,231 at Ismanig and to 3,602 at Freising, 19 miles below. Prof. PETTENKOFER claims that there is no danger from sewage pollution in a river, provided the amount does not exceed one-fifteenth of the stream's volume and that the velocity of the sewage flow exceeds that in the river and thus prevents banking up.

THE NICARAGUA CANAL PROJECT, says Senator ALLISON, of Iowa, will come up again in Congress this winter. The Senator regards the canal as a necessity and that it is further necessary that it be entirely under American control. He thinks the Senate would support a bill loaning the canal company $100,000,000 on the security and conditions offered, but he does not know what the House would do with the question. We trust the House would be as wise as the Senate.

THE HIGHEST TELEPHONE LINE in the world is said to be the one recently completed between Manitou and the top of Pike's Peak. The town of Manitou is 6,563 ft. above sea level, and the Peak is 14,115 ft. above the same datum.

The Indianapolis Cattle Guard Tests.

Our interested readers will have noticed that there has been a certain conflict of evidence in regard to the Indianapolis cattle guard tests of Oct. 13 last, between the two accounts which we have published in our issues of Oct. 24 and Nov. 14. We have since received the two following letters, both of them from authoritative sources, and both consistent with each other in all their statements and conclusions. The letters, therefore, sufficiently explain themselves and call for no summary of their conclusions.

We give herewith a sketch plan prepared from a photograph from which the general conditions under which the tests were made can be judged. As we have heretofore suggested, the tests seem to have been made under such severe conditions as to leave room for some doubt as to their decisiveness. The space back of the guards, in which the cows were confined, was quite narrow (15 ft.), and so "long drawn out" as to make it seem doubtful whether a cow would even attempt to do what it was the purpose of the test to make her do, *i. e.*, look the various guards over critically, and choose between them, before attempting to cross any one of them. An eyewitness of the tests, however, ought to be able to judge pretty well from the behavior of the cows whether the tests were really fair and decisive, and the letters below strongly indicate that they were so; but we should feel more confidence in the entire correctness of these conclusions if the tests were repeated with the cattle guards formed into a hollow square, instead of strung along in a line, and with a little more room behind the guards for the cattle to move about in and meditate over the problem before they attempted to solve it.

Peoria & Eastern Ry. (C., C., C. & St. L. Ry. Co., Lessee),
INDIANAPOLIS, Nov. 25, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Replying to your inquiry in regard to cattle guard test, held at Indianapolis Oct. 13, 1891: In January, 1891, I recommended that the National cattle guard be adopted as standard for the "Big Four" Ry., and soon afterward Mr. WM. GREENE, General Manager, approved it as standard. Several engineers of maintenance of way accustomed to running at large, and consequently are educated up to getting over and around obstacles that a country animal would pale at. It has been clearly demonstrated by the tests of Oct. 13, and more so by actual experience with the pit, National and Kalamazoo guards, that the pit guard is a better stock turner than any of the surface guards now on the market, and that the National guard comes next to the pit in this respect by a large per cent. over the other guards. The National guard also has the following important advantages over the other surface guards: It has a very permanent construction, and is so designed that it presents little liability to being torn up by dragging parts of trains. The Bush guard has the last mentioned advantage, but its stock turning advantages are not nearly so great as the National guard's.

We have had 20 Kalamazoo guards and 40 National guards in the track on this division during the past 8 months, and have had three reports of cows having crossed the Kalamazoo and one report of a cow having crossed the National guard. Three Kalamazoo guards have been torn up and entirely destroyed by dragging parts of trains (a dangerous operation) while none of the National guards have been so treated.

I have said that the national guard is slightly less effective than the pit guard for turning stock, but it is not a bridge in the main track, its maintenance is cheaper, it presents less danger to trainmen, and permits of the regular ballasted roadbed, which can be worked and maintained the same as the track each side of the guard by pulling six or eight spikes, and laying the three sections of each guard aside during the progress of the work on the track.

With the approval of General Manager J. A. BARNARD, I have decided to use the National guard in preference to the pit and other surface guards until something better is offered.

I inclose photograph taken at the test, which does not clearly show the construction of the guards, but it indicates the arrangements for the test. Those interested in such matters have doubtless familiarized themselves with the construction of the different guards.

Yours truly, E. T. MCCONNELL,
Engineer M. of W., P. & E. Ry.

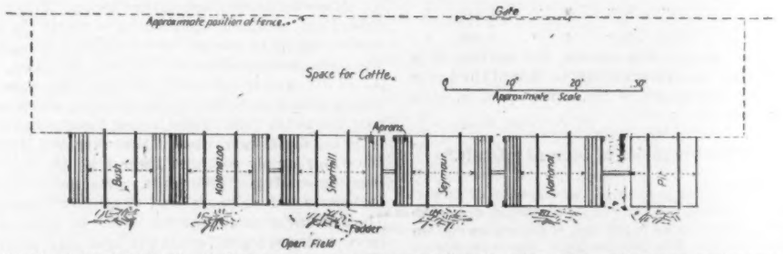
The second letter is as follows:

Pittsburg, Cincinnati, Chicago & St. Louis Ry.
INDIANAPOLIS, Ind., Nov. 22, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: We were much disappointed to note in the letter from Mr. J. T. HALL, Manager of the National Surface Cattle Guard Co., relative to the cattle guard tests at Indianapolis, Ind., published on page 468 of your issue of Nov. 14, that the complete facts were not stated, which makes the letter give a very incorrect impression to one who was not present at the tests. In a thorough test, which this was intended to be, a full statement of the case is absolutely necessary to enable correct conclusions to be drawn by the profession at large. As these omissions bear a very important part in the decision, we have been constrained to write this letter to correct an evident unfairness.

There were none more anxious than we to have the surface guard make the best showing, and we confess to have felt great disappointment in the results. We were so favorably disposed toward them that the engineers of maintenance of way of the Pennsylvania lines west of Pittsburg made a very exhaustive report on the subject more than a year ago, and recommended the National surface guard so strongly that our general officers allowed us to use them, and several hundred have been used by the system ever since. We have purchased 85 for this division this year. Through the courtesy of the National Surface Cattle Guard Co. and "Big Four" officials we were present at this test, being deeply interested in the results.



SKETCH PLAN SHOWING ARRANGEMENT OF CATTLEGUARDS, PEN, ETC., FOR THE INDIANAPOLIS TESTS.

(The cattle pen is plotted above as 17 ft. wide. It has since been ascertained to have been only 15 ft.)

The Indianapolis *Journal's* statement erred in the same way as Mr. HALL in his letter, namely, omission of part of the facts. The whole truth and nothing but the truth is required, and in this statement which we now make we speak as persons who much preferred to have the surface guard prove the superior rather than the pit guard, which we fondly hoped had been forever placed upon the

favored the use of the Kalamazoo guards and quite a number of these guards were received and placed in the track of various divisions of the "Big Four" on trial.

The test of Oct. 13 was arranged to show conclusively to the railway company and the cattle guard companies' representatives which guard was the most effective in turning stock.

I have noted in your issues of Oct. 24 and Nov. 14 the articles in regard to the test. Both articles vary somewhat from the actual facts as I noted them, which were as follows:

The cattle crossed and recrossed the Bush, Seymour, Kalamazoo and Short Hill guards with little effort and fear. One cow crossed the National guard from the inclosure leading to all of the guards before the entrance to the first four mentioned as having been crossed had been closed; and, after these entrances were closed, two or three cows crossed the National guard. Two cows crossed the pit guard (which was 28 ins. deep from base of rail to bottom of pit, instead of 40 ins., as stated in both previous articles), while the entrances to all other guards were closed, excepting to the National guard, but that was before the winged parts were fitted to the pit guard, as per this company's standard, which arrangement induced the cattle to endeavor to get over by jumping and twisting themselves round the end of the fences built up square to the center of the side of the pit guard. Wing fences were then built at each side of the pit guard, after which no cattle crossed the pit guard, as stated in one of the previous articles.

The cattle used at the test were city cows, which are

shelf as an interesting relic of ancient railroading. We still hope the surface guard will prove the conqueror.

Pardon this long preamble; we will now state the facts as observed by us.

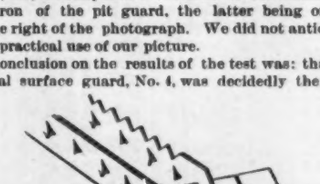
As the National surface guard No. 4 was decidedly the superior of the surface guards tested, we will only speak of it and the pit guard. All of the guards with the *single* exception of the *pit guard* were provided with aprons on the wing fences. Pause and consider what that means! It means that the pit guard was reduced to one-half its length in effectiveness. The expected result followed. A cow went up close to the wing fence and jumped over the other half of the guard, and this omission had not apparently been noticed till then. This was the second cow which crossed, the first having been literally pushed into the pit guard up to its belly by the crowd of cows behind it, whence it managed to flounder across with considerable difficulty. It makes no difference whether this occurred before the No. 4 guard was crossed or not. The omission of the aprons was then corrected and no more cows could be induced to cross even with corn stalks held temptingly close to their noses by one of the superintendents. Rather than cross the pit guard a cow jumped the wing fence alongside of it and broke off a board in the leap.

THE INDIANAPOLIS CATTLE-GUARD TEST.

(The pen for cattle (15 ft. wide) is in the foreground. The view shows one cow returning on the National guard after having passed over it to the fodder. The slats are barbed on the sides, as shown in the accompanying detail cut, though the barbs do not appear in this view. One corner of the pit guard (without the apron which was subsequently added) is visible at the extreme right. One of the authors of the accompanying letter is standing behind the middle of the further apron of the National Guard.)

Being on hand with a kodak to catch any interesting views on the fly, we forward to you a picture of one of them. This represents a cow deliberately returning over the No. 4 surface guard, without any corn-fodder inducement, after having just crossed it the other way. This picture, too, is indisputable evidence of the omission of the apron of the pit guard, the latter being on the extreme right of the photograph. We did not anticipate such a practical use of our picture.

Our conclusion on the results of the test was: that the National surface guard, No. 4, was decidedly the superior of any of the other surface guards, but the pit guard was the most effective of all, and we do not hesitate to say that this is the opinion of a large number of the *railroad* men who were present.



Detail of Slats and Slat-Support of the National Steel Surface Guard, No. 4.

We wish the surface guard a speedy and long success, and it is deserved by the company which has spent such large sums of money in trying to make it so, but we do not think it has reached that point yet. We desire to help on the fight by being a large purchaser when it is attained.

Trusting that this communication is of sufficient importance, and not too long for publication in a journal which desires only the truth, we remain, yours truly,

F. G. DARLINGTON, Supt.
WM. C. CUSHING, Eng. M. of W.

The National cattle guard, of which such favorable opinions are expressed in the above letters, was illustrated in our issue of Aug. 31, 1889, but with this important difference from the form used in these tests: The form of the guard then illustrated consists merely of parallel iron slats set on edge. The form of guard tested has (1) every other bar about an inch higher than the next, and deeply serrated on top, and (2) triangular teeth punched out of the side of the bar, in such manner as to project about an inch from alternate sides of the flat bar. This gives the guard a very formidable appearance, but on the other hand would seem likely to seriously injure any stock which might attempt to pass. The weight to be attached to this objection we do not attempt to estimate. Few valuable animals are allowed to be astray in the vicinity of cattle guards; but other things being equal it is desirable not to seriously injure stock.

European Rapid Transit Practice.

The following is the conclusion (slightly abridged) of the admirable report of Rapid Transit Commissioner OSBORNE HOWES, Jr., of Boston, the first part of whose report, on European street railways, appeared in our issue of Nov. 21:

THE GREATHEAD RAILWAY SYSTEM.

The tunnel railway in London, which has been one of the chief reasons for this investigation and report, is a system about which it is somewhat difficult to speak. If the so-called Greathead tunnels, with their stations, trains, etc., were to be literally copied in Boston, they would not give general satisfaction. They do afford a reasonably speedy transit. The distance from Monument station (in the city) to Stockwell, on the south side of the Thames, is 3¼ miles, and the space is covered, with unnecessarily long waits at the four intermediate stations, in 15 minutes. The speed might easily be increased and the delays at stations reduced, so as to make the distance in 10 minutes. Thus far the plan is a success, and in judging of other less satisfactory features it is only fair to take into account the conditions under which the tunnels were built.

The undertaking was in the nature of an experiment. Before those interested in tunnel construction of this class could obtain from Parliament the charter they desired it was necessary to prove by an object lesson that tunnels of the type proposed could be built, and, when built, could be successfully operated. The route selected for this trial was one from which a very large patronage could not be hoped for, and it was obviously for the interests of the promoters of the line to spend upon it no more money than was imperatively called for. The total cost was about $3 000,000; but the work shows the effects both of cheap construction and the conditions under which it was carried on. The tracks are not evenly laid, unlike most English railways in this respect; the cars are cheaply built, with poor springs and dingy furnishings, and are badly lighted, even though electricity is used, while the stations and their appointments are exceedingly unattractive.

Besides these defects, due in part perhaps to poor taste or bad judgment, but more to an insufficient supply of money to properly perform the work, the company was compelled to build its two tunnels under roadways, except when crossing under the river. This necessitated carrying the tunnels, one above the other, immediately after leaving the station in London, through a lane of only 12 ft. in width, reached by a curve and descent so sharp that the under tunnel of the two is built on an incline of 7%, and this on a curve having a radius of 100 ft. This may be a skillful piece of engineering, but it gives to the train a corkscrew motion, the disagreeable features of which are intensified to the passenger by the hard riding qualities of the cars. This is the worst point of all; but there are other places where the necessity of following the line of the streets has caused abrupt turns, that are not productive of comfortable traveling. Besides this, the size of the tunnel is small, 10½ ft. in diameter, and as quite a part of this space is taken up by the hydraulic pipes—which, receiving power from the central station at Stockwell, are used to run the elevators at all the stations—there is hardly more than 9 ft. in diameter allowed for the cars. The cylindrical form of these cars gives them a greater apparent size than they possess; but they are not large enough, either in fact or appearance, to suit American tastes. In consequence partly of the flanges of the iron covering, which protrude at short intervals into the tunnel for a distance of an inch or two, and partly because each tunnel is a single tracked one, there is a great and decidedly objectionable noise produced when the train proceeds at a relatively high rate of speed. This could be materially lessened, as it will be in the new Central London tunnel, by giving a smooth surface to the interior; but, after passing through some two or three score of single and double tracked tunnels in Austria and Northern Italy, I am of the opinion that a tunnel having dimensions only for a single track holds, echoes and re-echoes the sounds produced by a passing train in a manner quite without its parallel in a double tracked tunnel.

It will be seen, from what has been said, that there are a number of serious defects in the Greathead tunnel system, and it is exemplified in the London and Stockwell line. The question to consider is whether the merits of the system could be taken and its defects rejected in an American adaptation. It would be necessary to continue the single tunnel feature, for by means of this the expense is reduced and a cheap, easy and tolerably fair method of ventilation is secured, and if the tunnels were made smooth on the inside, filling up with cement the spaces between the flanges, it is probable that the noise now complained of would be very decidedly reduced. The stations, the elevators, the tracks and the cars could all be made so as to be much more sightly and comfortable—one or both; while if the tunnels could be run between stations in practically straight lines, not a little of the discomfort incident to travel in the London tunnels could be avoided. In other words, the Greathead system furnishes the suggestion, at least, of a method of urban rapid transit, which might be wisely adopted in Boston, if it is thought desirable to have a system of rapid transit entirely independent of, though connecting with, existing systems of transit, either of steam or street railway.

The trains start at intervals of 5 minutes, this being in accordance with Board of Trade regulations, which permit no train to leave a station until the train in front has left the preceding station. The engines have electric motors attached directly to their axles, thus doing away with gearing and also with a large part of the noise incident to the use of motors on our cars.

Mr. GREATHEAD proposes in the new tunnel, which will be 4½ miles long, to run trains at very short intervals by means of automatic devices which will prevent a following train from obtaining electric power when it approaches too near to a preceding train; and he will also arrange methods by which the signalmen can shut off the power from any train at their pleasure.

The Central London tunnel will have a diameter of 11½ ft., and will cost, simply for tunnel construction, about $1,000 per ft. Mr. GREATHEAD estimates that it will cost about 96 cts. per sq. yd. [so in report, but probably cu. yd. is meant.—ED.] to remove the earth; and is of the opinion, from his experience as consulting engineer of the North River Tunnel, that the expense would not be much more in the United States.

At the Stockwell station there is an opening to the surface of the ground, this consisting of a tunnel having an ascent of 10%, up which the cars and engines are dragged by hydraulic power, when it is necessary to repair them. There are at the central station 3 engines, 2 constantly employed during the hours of train service.

METROPOLITAN AND DISTRICT ROADS.

The underground steam railways of London are owned and worked by the two above named companies. The two lines form a circuit of 14½ miles, around which trains are run in each direction at intervals of about 10 minutes. Besides this several of the surface railway companies run a number of their suburban trains, some over the circuit and others to certain central points on one or the other of the two lines. In addition, both the Metropolitan and District companies have built suburban branches (surface roads), and trains are run from these both over the inner and over what is called the outer circuit. Altogether 18 trains an hour are regularly run during the day through the greater part of the tunnels and for a short time in the morning and evening 20 trains an hour are run. This, however, is the limit of capacity, particularly in view of the crossing of the tracks occasioned by connecting roads.

In the morning and evening the trains are full but in one direction, and during the middle of the day and also in the evening the patronage is relatively small; but it is found more convenient and even cheaper to keep all but the few extra trains mentioned running from morning to night rather than haul them off when demand slackens. The system of train running is made safely possible only by the most careful system of signaling. When distances

between stations are short, a train is not allowed to leave a station until a signal has been received that the preceding train has left the station in advance. When the distance between stations is longer, the train is allowed to go as far as signal lights placed in the tunnel, but must then stop, unless the signal is given to go on. In foggy weather the companies have men stationed at every signal light to warn the enginemen if the signals cannot be plainly seen.

The service begins at 4 A. M. and ends at midnight. The men in the signal stations are worked in three shifts, each man serving something less than eight hours a day. They are paid from $6 to $7.50 a week, and have every other Sunday off. The enginemen work in two shifts, serving about 10 hours each, and are paid about $2 a day. Firemen working under the same conditions get about $7 a week, guards about the same as firemen. There are two guards to each train.

The time required for making the circuit trip is 1 h. 10m. The fares are, for short distances, 4, 3 and 2 cts. per mile for the several classes. For longer distances the rates per mile are about two-thirds of those just given. Season tickets for first and second classes are sold for 1, 3, 6, 9 and 12 mos., for unlimited use, which, if used daily in making one trip in and out of town, would represent a reduction in fare of about 15% for the shortest and 30% for the longest time stated.

The two roads carry in a year about 40,000,000 passengers each They pay the interest on their bonded indebtedness, but give little or nothing to their stockholders. This financial result is due partly to the great cost of construction, averaging $4,000,000 per mile with the District road, partly to the conditions under which the money originally subscribed was obtained; that is, on the basis of two-thirds actual cash payment, and partly to losses caused by injudicious extensions. Until a few years ago the two roads connected at the west end of London, and together took the form of a horseshoe, the District road stopping at the Mansion House, and the Metropolitan at Aldersgate. It was thought that the closing of this space and the formation of a circuit road would greatly improve the business and receipts of both roads, hence the two companies each built lines to Aldgate East, and then jointly from that station to Whitechapel, Mile End. While this extension gave, besides the circuit route, a connection with the East London Railroad, its construction appears to have been a financial mistake, especially in the case of the District company. The extension it built had a length of rather more than a mile, and cost to construct fully $5,000,000 per mile, while its existence has added but little to the revenue of the company.

The tunnel railways are compelled to pump constantly at 8 different places to keep their lines free from water. The air in the tunnels is not seriously objectionable, but this result is obtained by having at intervals large openings over the track way, which, of course, involves the surrender of land that might otherwise be built upon, and by using exhaust fans, run by gas engines, at a number of different points. The noise in the tunnels is certainly less than in the single-tracked Greathead tunnels.

The tunnel lines are only of use for urban and suburban travel. No long distance trains are run over the lines, although transfer connections can be made at the different stations if persons have no heavy luggage. There is no provision made for handling trunks and the other large impedimenta of travel. It is held that to attempt to handle this would involve delays at the stations, and that it is better for persons coming or going over long distance routes to take a carriage to go to or from the stations and their homes or hotels The cars which are run upon the underground lines are much the same in style and construction as those which are used upon the surface railroads in England, but in new cars an effort is made to have them built lighter.

As may be inferred from what has been said, it is questionable if these underground roads can ever be made financially successful. The general manager assured me that if it were not for the suburban branches his company has built, it could not have avoided bankruptcy. But these branches, which are surface lines, cannot increase the number of trains they now run through the tunnel. For it is estimated that 30 trains an hour could be run around a strictly circuit road with greater ease and safety than 20 trains an hour can be run on the same circuit, when these trains are taken from or delivered to connecting lines of road. That is, when branch lines are connected with a circuit road, the delays incident to the crossing of tracks and to the providing of regular times for the running of these outside trains make very rapid and frequent service impossible. The larger the number of connecting roads, the more serious the delay. In order to improve its financial condition, as it must if its shareholders are to receive anything, the District company should enlarge and stimulate its suburban service; but its main tunnel line is now so occupied by trains during the busy hours of the morning and evening that it does not seem probable that it could add much to this part of its service. General Manager POWELL'S opinion was that a metropolitan line should be either a circuit road, without direct connections—that is, one where the passengers should transfer themselves, which, he admitted, would be an unprofitable system for the London District road—or should be built upon radiating lines. This last theory of radiating lines is one held, it may be added, by Mr. GREATHEAD, who will, no doubt, embody it in his future construction in London.

Mr. HOWES next reviews the main facts in regard to a proposed mixed circuit of underground and elevated railway in Paris, 7½ miles long, which has been heretofore (Dec. 13, 1890, &c.) described in these columns. The project is still too inchoate to warrant further description. A brief note in regard to the Mersey tunnel is also given, which we omit.

BERLIN ELEVATED RAILWAY.

The elevated railway in Europe which has deservedly the highest reputation is the Stadtbahn of Berlin, particularly when taken in connection with its connecting roads, the North Ring and the South Ring. The cost of the main line, which is 8.8 miles long, is stated to have been $16,270,000, this covering the outlay needed to build the viaduct and the structures of a four-track road. There were no walls or other open spaces, except the river Spree, that could be utilized; the land needed had to be condemned and purchased as in ordinary railway construction. At one point the price asked for the land was so great that it was thought advisable to utilize a part of the river; but the statement is made that by reason of the unsatisfactory foundations obtained, and the need the builders were under of providing better ones, it would have been quite as cheap, if not cheaper, to have purchased and built upon the high priced land.

The main viaduct is a masonry structure, except where a street crossing is made, when iron bridges are employed. In the suburbs the desired elevation is obtained by embankments. If the road were to be rebuilt, arrangements would be made to utilize the space beneath the tracks. Where by chance open arches have been left that can be utilized for store purposes, it has been found that the space can be rented, particularly near the stations, to exceedingly good advantage.

There are four tracks throughout the central road or Stadtbahn, two for distant travel and two for local business. These are kept wholly distinct, and the long distance trains do not stop at any but the larger stations on the line, and at these take or leave only passengers coming from or going to a long distance—that is, some place outside of the local service. At the present time the local trains are run at a headway of 5 minutes, and during quite a part of the day 12 trains an hour are run each way through the local service of the main line; but in a short time more the fares are to be reduced on the lines, and at the same time a larger number of suburban trains are to be put on, so that, with a headway of 3 minutes, there will be 20 trains each way per hour. These trains run with from 8 to 10 cars, each car carrying 50 passengers. The local trains stay in the stations, on stopping, from 15 to 20 seconds.

On the local trains there are only two classes of cars—second and third. The rates of fare in the third class are 2½ cts., for a distance represented by 5 stations or less, and 3¾ cts. second class. This distance is to be increased, with no change in price, to at least six stations for the purpose of encouraging local travel and inducing larger numbers to settle in the suburban districts. The manner of selling commutation tickets is highly commendable on account of its regularity. The tickets are issued without limit as to the number of times that their holders may ride while having them, at the following rates:

1 month the equivalent of	30 single fares.
2 months the equivalent of	50 single fares.
3 months the equivalent of	65 single fares.
4 months the equivalent of	80 single fares.
5 months the equivalent of	95 single fares.
6 months the equivalent of	110 single fares.
7 months the equivalent of	125 single fares.
8 months the equivalent of	140 single fares.
9 months the equivalent of	155 single fares.
10 months the equivalent of	170 single fares.
11 months the equivalent of	185 single fares.
12 months the equivalent of	200 single fares.

If a person holding a season ticket of three months or more wishes to leave town for a period of 14 days or more, he may, by giving notice at the registration office, have his ticket extended for a period equivalent to that which he does not propose to use it.

The main line is 8.8 miles long, with 10 stations. The North Ring route is 12.55 miles long, with 12 stations. The South Ring route is 16.30 miles long, with 9 stations.

It will be seen, when general averages are taken into account, that the single rate of fare which now obtains gives a ride of about 5 miles on the railway for 2½ cts. the third class, and 3¾ cts. in the second class. The running time from one end of the main line to the other, including stops (8.8 miles), is 29 minutes. Through the main line and over the North Ring (21.36 miles), 1 h. 25 min. Through the main line and over the South Ring (25.10 miles), 1 h. 25 min. This speed, while not high, is probably as great as that of any similar service in the world.

Where the stations are far apart, as on the South Ring, the effect of the system adopted of fixing fares is to benefit this somewhat sparsely settled district, by granting to it transportation at very low rates, for the policy of the government, as embodied in the direction of the road, is to encourage the building of suburban residences. It may also happen that, by grading fares on the station basis, the railroad authorities can prevent the demands for too frequent stations, as the establishment of a new one would have the effect of increasing fares to many who lived at stations beyond the one newly established, and their protests against such establishment could probably be counted upon.

The roads of the North and South Rings follow in the main the surface of the ground; but there are no streets crossed at grade, nor is there any railway track crossed except at different elevation. This statement does not, of course, apply to the points at the two ends of the main line, where the trains leave it for the North and South Rings. Here the tracks of the local, though not the long distance service, are crossed at grade, and will continue to be until the main line is provided with 6 tracks, 2 for distant business, 2 for the North Ring and 2 for the South Ring trains. This increase in tracks would involve large additional expenditures, but the officials appear to believe that it will before long have to be undertaken. When the road was first built the criticism was made that it was far too extensive for the demands of travel for a generation or more to come. But, though the main line was opened in February, 1882, the passenger traffic upon it has grown so rapidly that already the question of the sufficiency of facilities has been brought up as a practical matter. With two tracks only devoted to the local service, and with a maximum number of 20 trains an hour each way it is probable, considering the hours of travel, that 150,000 passengers a day would be all that the main line could carry; and, although this number is much more considerable than that which would represent those now carried, it is no larger than the number who daily arrive and depart from a single London station. The Stadtbahn and the Ringbahn of Berlin have, in the opinion of good authorities, tended greatly to stimulate the growth in population of the city; but that growth is having the effect of making insufficient the facilities furnished.

(*Concluded on page 548.*)

The Steel Skeleton Type of High Buildings.

BY CORYDON T. PURDY, C. E.

A great deal is heard nowadays in building circles about steel construction in buildings. Our daily papers often discuss the subject, and every stranger

THE WOMAN'S TEMPLE, CHICAGO.

in our midst is impressed by the sight of great buildings of metal, taking form almost like magic. Very few people not immediately concerned in the erection of these structures have any idea of the great change that iron work in buildings has made in general methods of construction or of the magnitude of the interests involved, and it might also be added with equal truth that few engineers not engaged in designing these structures fully realize how important and intricate are the problems which are involved. The steel frame of a building ought not to be a mere pile of steel beams and columns. And in the best buildings, especially in the

city of Chicago, where the construction of great steel buildings has been rapid beyond all precedent, every detail and every connection is studied, and the whole is braced so completely that the frame may be raised hundreds of feet high, if desirable, from foundation to roof without the aid a mason's trowel or a carpenter's hammer; a great steel skeleton, strong in its own strength, not only to carry the direct loads which may be placed upon it, but also to resist all lateral strains to which it may be subjected.

In these buildings, where the steel construction is used throughout, heavy masonry walls are not known and what appears to be such in the finished structure is only a sham, a veneer of fireproof material which may be made as elaborate and costly as the owner of the building is willing to pay for. Incidently steel construction implies an interior construction of partitions which may be changed at any time and in many ways without injuring the building, and an interior finish entirely independent of the rest of the construction. In some of these structures the loads are all carried on steel columns, but in others there are heavy brick party walls. The outside is covered with brick, terra cotta, tile, marble or granite, or combinations of these materials, as the architect may design, supported by spandrel beams at each floor level. These spandrel beams are placed over the windows in such a way that all the load is taken off from the window caps, however it may appear in the finish. In some cases the walls of the lower stories are made of stone, very heavy at least in appearance, and more or less self supporting from the foundations; but above this are the filled walls carried on the iron, often only 9 in. thick and rarely more than 16 ins. The outer finish of these walls is usually pressed brick or terra cotta, while the backing is generally made of hollow brick or tile. This material is so completely carried on the iron work that there would be no danger whatever in removing part of it. For example, between the fourth and fifth floors this construction might be taken away entirely, leaving the interior of the building exposed, without displacing or injuring any of the walls above the fifth floor.

The floors are carried by tile arches between the beams, both beams and arches being covered by a layer of concrete, which in turn carries the finish of wood or tile. Partitions are built of hollow tile or some other like fireproof material generally about 4 ins. thick before plastering. The positions of some of these partitions are fixed by the nature of the building or the general scheme for its use, but most of them are placed to suit the interests of the tenants when the rooms are leased, and may be changed from year to year whenever such interests make it advisable. All the wood trimmings about doors and windows, marble wainscoting and all other finishing materials throughout the interior of the building are purely superficial, and can be removed or replaced at any time without any injury to the building proper. The steel is the skeleton, the filled exterior walls and the solid floors are the body, while the rest is hardly more than clothing.

This construction of buildings is a comparatively new thing in architecture. Like all other movements in construction it has been produced by a species of evolution, truly a rapid one, yet, step by step, with no very great departure into the new and untried in any one building.

Steel beams have been used ever since our mills began to place them on the market in any available quantities. Before the steel beams could be had, iron beams were used in comparatively small quantities in connection with cast iron columns. The steel beams are lighter and stronger than the iron, and the sections are also much better for riveting and fitting, and with ruling prices are more economical.

After the steel beams came the change from cast iron to steel columns, and from the massive walls to the filled walls supported on spandrel beams. These changes have been independent of each other and have not always gone together, though they are both typical of steel construction. There are a good many buildings constructed with cast columns having filled walls, though very few are extremely high. The casual observer would scarcely notice, from the outside at least, any difference between a building with filled walls and one with solid piers. Indeed, so perfect is the imitation sometimes that those familiar with such construction can scarcely tell which is which. This can be appreciated better by comparing the appearance of the Womans' Temple and the Venetian Building, in Chicago. In the former all the exterior lines of the building are made of heavy brick piers and walls with only certain walls and mullions supported on steel; while on the Venetian Building there are no self-supporting walls at all. The latter is a strictly steel constructed building with all the weight of the building carried on columns.

The quantity of light desired in the building, a careful consideration of renting area and sometimes questions pertaining to foundations govern in the choice between using masonry piers or walls and columns along street fronts or party lines. A steel section of 1¼ to 2 sq. ins. will carry as much load as a square foot of section of brick masonry. A great many columns in high buildings carry a load of 1,000,000 lbs. This would require a steel column not much larger in obstructing area than the smallest columns

THE VENETIAN OFFICE BUILDING, CHICAGO.
Holabird & Roche, Architects.

made, but in a brick pier it would require an area 5 ft. thick and 9 to 10 ft. long, and this too in that part of the building where the rent is most valuable and where the light is needed most. It is this element of the problem, usually, that makes the use of columns along the exterior as well as in the interior of the building so desirable. At first so much glass in the front of a great building and so little solid surface was a novelty, and its appearance of weakness in contrast with the older, heavier buildings drew forth a quite general disapproval. This distrust is unfounded, and those who build and will inform themselves on the real merits of the question are ready to demand the light, and object to the loss of income due to great areas of masonry. The higher buildings are built, the more serious this view of the problem grows, and so the piers are being abandoned and the more complete use of columns throughout a building is increasing.

The change from cast iron to steel for column metal in very high buildings has been pretty generally adopted by the prominent architects of Chicago. The change has slightly increased the cost, some business interests have been antagonized, especially those of the foundries, and prejudices have had to be overcome. One after another the advocates of cast iron have fallen into line in favor of steel in our very high buildings and it is quite possible that the day is not far away when cast iron columns will be prohibited in such structures. Cast iron columns have been used in several of Chicago's notable buildings, the Auditorium, the Rookery, the Home Insurance, the Tacoma Building, and the Chamber of Commerce, but the movement for steel columns did not fairly begin until after all these buildings were finished. The new buildings that have been undertaken since these were built, using cast columns, are the Monon Block, Manhattan Building, Owens Building, Western Bank Note Building, Unity Building and the Cold Storage Building. Meantime the list of steel structures in Chicago has rapidly grown. The Rand-McNally Building, Pontiac, Caxton, Kearsarge, Monadnock, the Northern Hotel, The Fair, Woman's Temple, Masonic Temple, Ashland Block, Cook County, Abstract Building, Venetian Building, German Theater, the building for the Chicago Athletic Association and the Northern Pacific Railway Depot, all have steel columns.

Cast iron columns can be produced more quickly and cheaply than steel columns, and these are two very important factors in the problem. The foundry men desire to keep the cast iron in the market and they bring every influence and argument to bear where there is a possible chance of gaining a point. There is, however, a growing distrust of cast iron columns in high buildings among sober, thinking men. They know that when a piece of cast iron breaks it breaks suddenly and completely, that steel will bend a great deal without breaking, and that rivets are stronger and better than bolts. These are the three plain and most important facts counting against cast iron. If it is used at all the connections must be made with bolts, which never completely fit the holes. All thoughtful men can see at once that this arrangement can not make as stiff a structure as the steel, which can be riveted in every connection. They may know very little of the technicalities of computations pertaining to the strength of either, or of important considerations in the manufacture. These simpler facts are enough for them and ought to be for every man. The use of cast columns in 16 to 20-story buildings ought to be prohibited by law.

Structural steel, comparatively speaking at least, is a uniform product. The construction of railways and great bridges has produced the demand, and the wealth of a great industry has been spent in perfecting the methods of its manufacture. Cast iron on the other hand is not uniform. The product of one foundry is no criterion for that of another, and even in the same place the columns turned out in one day will sometimes vary greatly in the perfection of their manufacture. The methods of the manufacture of the two make the difference necessary, and it is hardly possible to overcome it.

The method of inspecting steel from the beginning of its manufacture to the finished product is definite, thorough and very reliable. If the inspection has been done with even ordinary care, one can feel assured that the steel column will do the work it was designed to do. With cast iron it is not so. The very best inspection that can be given will not assure a perfect column. A bad fault in casting may be covered up by a perfect surface. It is even necessary to drill small holes through the column to determine if the metal is as thick as required. Those who advocate the use of cast iron in any and every kind of a building contend that these deficiencies can be covered by using a larger factor of safety; that is, by increasing the weight of metal. If this is done, however, as it should be, to make cast columns acceptable for very high buildings, they will cost quite as much as the steel columns, and the one telling argument in their favor is destroyed.

Cast iron appears to be rigid and unyielding, but really its coefficient of elasticity is lower than that of steel, and the cast iron column is not as stiff as the steel column, and will not, on the whole, pro-

duce as rigid and unyielding a structure. More attention is being given to the bracing of our large buildings against wind forces, and when this bracing is part of the iron construction, as it ought to be, the difficulty of doing it properly with cast iron columns is almost, if not quite, insurmountable, and these difficulties are largely removed by the use of steel columns. In almost all our large buildings the ideas of the owners are changing and growing as the building takes form, and they never hesitate to ask for the most radical changes of design when it is almost impossible to make them. If the building is entirely of steel many changes can be made, for steel columns can be drilled and riveted, where the same changes would be impossible if the columns were made of cast iron. And there are other reasons why it would be better to use steel columns in our very high buildings, at least, instead of cast iron.

Steel construction has done much to lighten the dead loads, and so has contributed largely to making very tall buildings possible. Some prominent men in Chicago have expressed the fear that some day the semi-liquid strata beneath Chicago would be displaced, and that the foundations of these high structures would push through the harder clay on top into the mud below. These alarms must be based on the supposition that what looks so very large must be very heavy. The truth is, the loads are not increased; indeed, they are less than those under some very much smaller buildings of the old type. The Fair might be given as an illustration. There is no high building in the city designed to carry heavier live loads and everything about the building is massive; yet the actual dead load including the weight of the foundation is only 2,900 lbs. per sq. ft. This is due to steel construction and improved methods of fireproofing, and it is an important consideration for other places beside Chicago.

The rapidity with which these structures can be put up and made habitable is startling. In a few short months the ordinary work of as many years is accomplished. And these newer methods of construction have done much to make this possible. The engineering involved in the steel construction of buildings is much more complicated in detail than is generally supposed, and involves many difficult problems. It matters little what ordinance may be passed concerning the future of high buildings, steel constructing will continue and the possibility of the future for great buildings is immeasurably great.

(To be continued.)

The Comparative Merits of Various Systems of Car Lighting.

XII.

ELECTRIC LIGHTING (*Concluded*).—AMERICAN PRACTICE IN THE COMBINED DYNAMO AND STORAGE BATTERY SYSTEM.

The chief user of the electric light on railway trains in America has been the Pullman company. Their early introduction of the storage battery system to light two of the Pennsylvania limited trains between New York and Chicago, we described last week. Very soon, however, the charging or changing of the storage batteries at the terminals was found to cause too much delay and expense; and while the storage batteries were retained under each car, thus rendering it independent in case of necessity, an Eickemeyer dynamo and Brotherhood 3-cylinder engine, taking steam from the locomotive boiler, were placed in the baggage car to keep the batteries charged and light the train. A space in one corner of the baggage cars, 3½ × 5 ft., is partitioned off with lattice work; and the engine and dynamo are placed inside, both being mounted on one cast-iron bedplate. The steam from the boiler is passed through a reducing valve, and reaches the engine at a pressure of about 60 lbs. The exhaust steam is passed into the car heating pipes, which causes about 15 lbs. back pressure. Both engine and dynamo are automatically lubricated, the supply of oil being sufficient for one or two round trips. The dynamo at 800 revolutions gives about 60 ampères of current of 68 volts E. M. F.

Under each car are 32 storage battery cells, weighing with their boxes about 1,300 lbs. When the dynamo is running, the batteries furnish about 30% of the current, and when the dynamo is not running, they of course furnish all the current. The batteries are charged by running the dynamo several hours during the day when the lamps are not lighted. An attendant (who is paid $90 per month and board) makes the trip regularly with the train, and an expert also examines the train at the terminal stations. The perfection of the details of the system in use on the Pullman trains has been chiefly due to Mr. A. H. BAUER, the manager of the Pullman Company's electrical department. The system is in use on the Pennsylvania Limited trains between New York and Chicago, the Chesapeake & Ohio's "F. F. V." express trains between New York and Cincinnati, and on a number of the important express trains between Chicago and principal Western points.

COMPARATIVE COST OF DIFFERENT ELECTRIC SYSTEMS.

On the question of reasonable cost more than on any other, the practical success of electric car-lighting depends. Everyone admits that the electric light is cleaner and more pleasing than any other, and lends itself more readily to decorative effects. It can be divided into smaller units than any other, and can be placed in more advantageous positions; for instance, it may be used for reading lights or berth lights. It is absolutely unaffected by drafts. It maintains its original candle power better on the whole than any other light, and is less dependent for its excellence on the faithful care of the trainmen. Its safety will hardly be questioned; and while it is confessedly a little weak in the matter of reliability, yet if installed and maintained with proper care it ought to be reliable enough to dispense with anything but candles for auxiliary lighting.

Conceding, then, these important advantages of the electric light, the question as to the advisability of its use turns upon matters of cost and convenience. Or, to adapt an old proverb which is peculiarly pat in this case, we must see whether the candle is worth the game!

Further, as the merits of the electric light itself are pretty much the same, no matter what system is used for providing the current, the question what system of electric lighting is best suited to compete with gas, oil and other systems in use, is also one of comparative cost and convenience.

We have already seen that the track wire system, while possibly applicable with advantage to elevated railways, is manifestly unsuited for general use; and that the primary battery system* is certainly out of the race on account of its great cost if for no other reason. The storage battery system, too, has had a thorough trial; and, as at present operated, its expense and inconvenience have proved it to be inapplicable to general service. The field is narrowed, therefore, to the direct dynamo system and the combined dynamo and storage battery system.

The fact that the former system requires the train to be kept solid and makes all the cars dependent on the plant in the baggage car for light is a practically insurmountable objection to the general use of the system. On express trains making long runs, and neither taking on or setting cars off on the trip, this system may be used, perhaps, without great inconvenience. Yet even here the cars have to be equipped with a complete set of oil lamps at all times ready for use. The stoppage of engine or dynamo from any cause, the breakage of the steam supply hose, the separation of the train for any of the many causes which make such separation necessary in railway service, an accident to the baggage car necessitating its withdrawal from the train,—any of these various causes may leave the train in darkness until the oil lamps can be lit.

Of these objections, those of most importance—the necessity of keeping the train solid and the extinguishing of the lamps whenever the train is separated—apply with equal force to that form of the combined dynamo and storage battery system in which the storage battery cells are all located on the same car as the dynamo.

The conclusion is irresistible, then, that the only system of electric lighting thus far tried which stands a chance of competing in general service with other well known systems of car lighting is the combined dynamo and storage battery system, in which each car is supplied with sufficient storage battery cells to light it for a considerable time, independently of the current from the dynamo.

But while this system is admittedly the superior in convenience, the direct dynamo system and the system having storage battery cells on one car only are certainly cheaper systems in first cost, and might perhaps be preferred by a railway manager equipping a few express trains only, with electric lights. We have therefore collected figures of cost for each of these systems as follows:

Direct Dynamo System.—The fullest and most reliable figures available for this system were given by Mr. GEO. GIBBS, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry., in his paper before the Western Railway Club last spring (ENGINEERING NEWS, March 14, 1891). He gave the following as a close estimate of the cost of equipping and operating a 50 ft. standard passenger coach with this system, the coach to have nine lamps of 16 c. p. in the main body and one in the closet:

First cost of equipment	$395.40
Cost of equipment per candle power	2.47
Depreciation and 5% int. on first cost	36 35
Total running cost per car per hour	9.83 cts.
" " " " lamp "	.98 ct.
" " " " candle power per hour	.061 ct.

The "first cost of equipment" includes $113 for auxiliary oil lighting equipment for each car, consisting of 6 Acme lamps in the main body and one in the closet. It also includes each car's proportion of the cost of the "light and heat tender," or separate car on which the engine, dynamo and boiler are placed, figuring on the basis of one tender car to each 15½ cars in service. The depreciation is figured at 10 % on the tender car and its equipment and 5 % on the wiring and the oil lamps. Lamp renewals are computed as part of the total running expense. The details of these "running expenses" for one trip in the month of October, 1890, were given as follows:

Train of	10 cars.
Running time	11 hours.
Maximum lamp load	152
Average lamp load	87.3
Indicated horse power hours	85.6
Water per indicated horse power hour	57.8 lbs.
Water per trip for lighting	4,948 lbs.
Evaporation at boiler pressure per pound of coal	5.7 lbs.
Coal used per trip	868 lbs.
Lamps per indicated horse power	10.5
Coal per indicated horse power hour	10 lbs.
Cost of coal per ton	$2.00
Cost of coal per horse power hour	1 cent.
Attendance	$5 25
Lamp renewals (3 at 40 cts.)	1.20
Oil and waste	.40
Miscellaneous supplies and repairs	.80
Coal for light	.87
Coal to haul car	2.00
Total cost per trip	$10.52
Or, per car per hour	9.54 cts.

This is the running cost alone; but the interest and depreciation on the original equipment amounts to little in comparison. That little, however, should properly be added. Taking Mr. GIBBS' figures of $36.35 per car as a fair estimate of this, we have 11 hours' service per trip for the car and, say, 300 trips per year, making 3,300 car hours, or 1.1 cts. per car hour in addition to the running expenses. This makes the total cost of this system 10.93 cts. per car hour, 1.09 cts. per lamp hour (16 c. p.) and 0.068 cts. per candle power hour.

The Metropolitan Ry. of England (better known as the London Underground) experimented with this system in 1884. The train had 52 lamps of 18 c. p. each, and the light was used 8 hours per day. The cost of lighting, not including labor, was estimated at 1.375 cts. per lamp per hour. The cost of labor would probably double this, making the cost about 2.75 cts. per lamp hour. It is to be remembered, however, that an enormous advance in electrical matters has been made since the date of this experiment. The improvements in lamps alone, which are now very much cheaper and far more durable, would materially alter these figures.

The London & Northwestern equipped a train with the direct dynamo system in August, 1884, which has been running ever since. The following figures concerning its cost were given by Mr. J. W. FLETCHER, the company's electrician, in the discussion on Mr. LANGDON'S paper (abstracted last week).

The first cost amounted to £22 4s. 1d. ($10.24) per lamp (16 c. p.) and "their experience of the first year's running" gave the cost per lamp hour at 0.628d. (1.268 cts.)

Estimating interest and depreciation at 10%, and

*At the International Railway Congress held at Milan, Italy, in September, 1888, it was stated that a car was running between Brussels and Paris lit by 14 electric lamps of 10 c. p. (nominal) furnished with current from primary batteries. The first cost of equipment is $972. The cost of operation is about 73 cts. per hour for the car, or a little over 5 cts. per lamp hour, or ½ ct per candle power hour. The battery cells have to be charged with new liquid every fourth trip, and new zincs are supplied every sixteenth trip.

annual service at 3,300 hours we have the total cost as 1.271 cts. per lamp hour or 0.08 ct. per candle power hour.

Combined Dynamos and Storage Battery System with Battery Cells All on One Car.—As stated above, the London, Brighton & South Coast Railway has had the most experience with this system. The following figures for the cost of its installation and operation were published a year ago as coming from MR. HOUGHTON, the company's electrician.

The trains on which this system is used consist mostly of 10 cars which run solid (that is are not broken up), and average about 40 lamps (12 c. p.) to a train. The total weight of the plant on each train is three tons; the cost of plant is £400 ($1,940), and the cost of maintenance per annum is £65 ($315). The only attention given the trains is at each terminus, where one man inspects the apparatus and oils the pulley bearings.

If we estimate interest and depreciation on the above original investment at 10%, this brings the the total cost per annum to $509 per train. If the number of lamps is 40, of 12 c. p. each, and the hours service per annum is 3,300 (the same as estimated for the Chicago, Milwaukee and St. Paul above), we have the total cost as 0.385 cts. per lamp hour, or 0.032 cts. per candle power hour.

The Connecticut River road has had considerable experience with the system in which the battery cells are all located on the baggage car; but it uses an engine to drive the dynamo instead of taking power from the car axle, experiments with the latter method having resulted unsatisfactorily. It has been stated that the first cost of equipping the train on this road, 71 lamps being used, was about $2,500. The annual cost of operation was as follows:

Interest on capital (6%)	$150
Lamp renewals	50
Sinking fund	100
Repairs and attendance	30
Coal and stores	156
Total	$486

Estimating as before 3,300 hours service per annum, this makes the cost (for 71 lamps on the train) about ½ ct. per lamp hour. This, however, is manifestly much lower than the actual cost, since there is nothing allowed for an auxiliary system of lighting; and the "sinking fund," which is supposed to cover depreciation, is evidently inadequate.

Combined Dynamo and Storage Battery System with Battery Cells on Every Car.—In Mr. GIBBS' paper above referred to he gave an estimate of the cost of installing and equipping this system, based on the experience with it on the Chicago, Milwaukee & St. Paul. The system, which was practically the same as that in use by the Pullman company (described above), was used for a year on two trains on that road. The weight of storage batteries on each car was 1,500 to 2,000 lbs. Mr. GIBBS' estimate, based on this experience, for the equipment of a standard 50 ft. passenger coach, having 9 lamps in the body and one in the closet (all of 16 c. p.), was as follows:

First cost of equipment	$863.00
Cost of equipment per candle power	5.40
Depreciation and 5% int. on first cost	137.47
Total running cost per car per hour	13.20 cts.
" " lamp "	1.32 cts.
" " c. p. "	0.082 ct.

The "first cost of equipment" includes the storage batteries, the car's proportion of engine and dynamo and $113 for auxiliary oil lighting equipment. Depreciation is figured at 25% on the Brotherhood engine, 10% on the Eickemeyer dynamo, 33⅓% on the storage batteries and 5% on wiring and oil lamps.

Adding the charge for interest and depreciation to the running cost, estimating 3,300 car hours service per annum, as before, we have a total cost with this system of 17.36 cts. per car per hour, 1.74 cts. per lamp hour, and 0.102 ct. per candle power hour.

The cost of this system as used on the Pennsylvania limited trains by the Pullman Palace Car Co. was given as follows by Mr. CHAS. SELDEN, Superintendent of Telegraph, B. & O. R. R., in a paper read at the Telegraph Superintendents' Association Convention in 1889:

	First cost of equipment.	Annual depreciation.*	Int. at 5%.
Baggage car	$1,840 25	$156.00	$93.19
Day coach	461.87	121.63	26 26
Sleeper	501.23	185.22	31.07
Dining car	486.58	158.74	29.07

On the above basis Mr. SELDEN estimated that a train consisting of baggage, smoker, day coach and two sleepers would cost to equip $3,772.45. Depreciation would amount to $769.79, and interest to $207.85, making a total of $977.64 for "fixed charges." An attendant at $80 per month would cost $1,680 per year, making the total cost per year for the train of 5 cars $2,057.64. The total number of lamps on the supposed train is 85; and estimating the hours of service per annum at 3,300, as before, we have the total cost as 0.734 ct. per lamp hour or 0.046 ct. per candle power hour. It will be noted that Mr. SELDEN's estimates for depreciation are much below those of Mr. GIBBS; and he makes no allowance for auxiliary oil lighting equipment nor for the cost of coal, oil and waste.

The figures thus far given are all estimates. We have, however, been favored, through the courtesy of Mr. WILLIAM GARSTANG, Superintendent of Motive Power of the Chesapeake & Ohio, with the following figures of the actual cost of the electric light on the limited express trains between New York and Cincinnati running over that road:

For the 12 months ending June 30, 1891, the total cost of labor and material used in operating electric light on Chesapeake & Ohio trains was	$13,110.04
Making the cost per day	36.40
The average number of electric lighted cars in operation per day is 10, and the average number of lamps per car is 12, making the cost per lamp per day	.30
Assuming that the lights are in actual service 12 hours per day, the average cost per lamp per hour is	2½ct.
And per candle power hour is	.156ct.

This, it is to be noted, is for running expenses alone; interest and depreciation (so far as the latter is not made good by current repairs) are not included.

On the Midland Ry. (England) as described last week, the dynamo is driven from the car axle, but storage battery cells are placed beneath each car. The first cost is given by Mr. LANGDON at £50 ($243) for a "6-bodied coach" having 12 lamps (8 c. p. each). The cost of the dynamo and running gear is £250 ($1,215). At one dynamo for each 10 cars fitted this would add $121.50 as each car's proportion of the first cost of the generating plant, making the first cost per 16-c. p. lamp $60.75. No more definite idea of the cost of operation of the system is given by Mr. LANGDON than that his experience "inspires him with the belief that the cost per 8 c.p. lamp per hour will eventually be considerably less than ¼d. (½ ct.)" It is perhaps fair to conclude from this that the cost at the present time is somewhat in excess of this, or at the rate of over 1 ct. per 16 c. p. lamp per hour.

To admit of ready comparison of these different figures of the cost of electric lighting, we have tabulated them as follows:

System and Road.	Total cost per lamp hour.	Total cost per candle power hour.	Remarks.
Direct dynamo:			
Chic., Mil. & St. P.	1.09 cts.	.068 ct.	Careful estimate.
Metropolitan (1884)	2.75 "	.153 "	Short experiment.
London & No. W'n	1.27 "	.080 "	Probably accurate.
Combined system: Battery on one car.			
Lond., B. & So. Coast.	0.385 "	.032 "	No charge for power used.
Conn. River	0.200 "	.013 "	Incomplete.
Combined system: Battery on each car.			
Chic., Mil. & St. P.	1.74 "	.102 "	Careful estimate.
Pullman system.			
Selden's estimate	0.734 "	.046 "	Incomplete.
Ches. & Ohio	2.500 "	.156 "	Excluding int. and depreciation.

It must be admitted from the above showing that the use of the electric light is hardly advisable at present for any railway which is not willing to go down deep into its pocket to pay for the luxury. We believe Mr. GIBBS' figures to be the most accurate of any of the estimates in the above table; and he explicitly stated in giving these figures that the low cost was only attained through unusually favorable circumstances. If this is the case, the conclusion is inevitable that electric lighting in the present state of the art is not applicable for general use in lighting railway cars. The direct dynamo system we have seen to be certainly unavailable, on account of its inconvenience; and if 1¾ cts. per lamp hour is a minimum for the total cost of the combined system, with storage batteries on each car, it certainly cannot compete for general use with the established methods of car lighting.

On the other hand, it must be freely acknowledged that the last has not been heard from electric car lighting, and that it is by no means unlikely that it may yet become one of the most common systems of train lighting. A study of the detailed items of cost in Mr. GIBBS' estimate for the direct dynamo system shows that nearly half the total operating expense is for attendance, and 20% of the remainder is for the coal used to haul the special car used. If, now, the electrical generating apparatus can be so simplified that it can be placed in charge of the engine driver or baggage master, and is located in the baggage car or on the tender, about 70% of Mr. GIBBS' expense account will be wiped out. This has been done in England; it ought to be possible here.

The next most important step will be to improve the storage battery, and so increase its durability, efficiency and capacity that its use under any passenger car will be practicable. This is a task on which many inventors are at work; and able electricians look for their success.

With these two steps taken, and with such other improvements in the whole apparatus as may confidently be expected, the cost of train lighting by electricity may be reduced to a point where it will compare favorably with that of the long established methods of car lighting.

Further than this it would be useless to prophesy, for the possibilities of improvement in the efficiency of electric lighting apparatus are so great that a single discovery may possibly upset even our conclusion above that the primary battery has no chance in the race. Necessarily we have dealt in this paper only with the present state of the art, when the best incandescent lamp gives to us in the form of light only about five per cent. of the energy existing in the electric current which it uses, or perhaps four per cent. of the energy imparted to the engine which drove the dynamo. But GEISSLER's tubes, which are still a laboratory toy, are said to convert as much as 30% of the electric energy imparted to them into light. When NIKOLA TESLA or ELIHU THOMSON or some other electrical expert finds a way to double, quadruple, or multiply tenfold the efficiency of the electric current as an illuminant, the problem will be wholly changed, and electric lighting may then become the standard method of car illumination.

THE CRUISER *New York*, which was launched at Cramp's ship yard in Philadelphia on Dec. 2, is 380 ft. long, 64 ft. beam, draws 24 ft. and has a displacement of 8,150 tons and engines of 16,500 HP. She will be armed with six 8-in. guns and 12 4-in. guns, and has 4-ins. of armor on her sides and 10 ins. on the barbettes. The contract price was $2,985,000 and the contract was signed on Aug. 20, 1890. The *New York* must be finished by Jan. 1, 1893, and Mr. CRAMP says she could be completed in nine months if necessary.

THE SEA WALL PROTECTION around Governor's Island, New York Harbor, is nearly finished. Part of the wall around old Castle William at the western end of the island was built in 1811-12, and is still in excellent condition. Contractors Breuchand, Pennell & Co., of Yonkers, have during the past season extended the wall along the south side of the island, and when their work is completed only about 300 ft. will remain to be protected. The same contractors are removing eight masonry magazines which obstruct the parade ground. The magazines are rectangular chambers about 6 ft. wide, 8 ft. high and 15 ft. long, with walls of solid concrete 4 to 5 ft. in thickness. The roof is an arch of concrete about 2 ft. thick. To break up these magazines from 20 lbs. to 40 lbs. of 40% dynamite is placed inside the chamber, the doorway in the end is filled with earth solidly tamped, and the charge is exploded. The concrete of which the walls are made would hardly pass muster in these days, the solid components being of every size and grade of material, from smooth, water-worn boulders 2 ft. in diameter to broken bricks. Good cement seems to have been used, however, and the toughness of concrete is well attested by the action of the dynamite. A 40-lb. charge only breaks up the walls into pieces weighing from ½ ton to 15 tons, and shatters them very little. The fact that the bottom of the magazines is about 6 ft. below the

* Mr. SELDEN estimates depreciation on engine at 10%, on dynamo at 3%, on storage battery cells at 16⅔, on lamps at 700%, shades at 10%, lamp sockets at 10% and nothing for wiring or other apparatus.

ground level helps of course to explain the small amount of shattering.

UNIFORM standard time has been adopted by the German and Austrian state railways, says the *Eisenbahn Zeitung*. The Greenwich meridian is taken as the starting point, and the central line of the new time zone is just 15° east, or one hour in advance of Greenwich time. Within this zone are the railway systems of Germany, Austro-Hungary, Servia and the Zibeft-Salonica line.

FIVE MORE 16-STORY BUILDINGS are to be erected in Chicago. Permits were lately issued by the building department as follows: The Marquette Building, to cost $900,000; to FRANCIS BARTLETT, for a building to cost $800,000; to BYRON L. SMITH, cost $400,000; to DAVID E. BRADLEY, cost $600,000, and to Mrs. SARA L. BROOKE for a building to cost $600,000. All of these structures will be 16 stories high, and will be used for offices and stores. The contracting firm of George A. Fuller & Co. has full charge of all work.

EUCALYPTUS PAVING BLOCKS have been used in Melbourne, Australia, on about 40 miles of streets and tramways. Some blocks laid in 1882 have been taken up, and the wear amounted to only ⅛ in. In addition to the *Eucalyptus rostrata*, or "red gum," two other varieties, the "black-butt" and "tallow wood," have been tried in Sydney, and blocks laid in 1885, with half-inch joints grouted with pitch screenings and tar, showed recently an average wear of .094 in. per annum.

PERSONALS.

Mr. JULIEN A. HALL, M. Am. Soc. C. E., has resigned from his position as Engineer of the Richmond & Danville R. R. Co., on account of poor health.

Mr. F. E. HOUSE has been appointed Principal Assistant Engineer of the Lake Shore Division of the Lake Shore & Michigan Southern Ry. Co., with headquarters at Dunkirk, N. Y.

Mr. ALBAN EAVENSON has been appointed Acting Chemist of the Lehigh Valley R. R. Co., in place of Mr. C. P. COLEMAN, who has been transferred to the office of the General Eastern Superintendent.

Mr. CHARLES F. CHASE, C. E., of Providence, R. I., recently sailed for Europe to examine the best sewerage and sewage disposal works in England and on the continent. He will also see the more important water-works systems.

Mr. JABEZ M. WOODWARD, C. E., died on Nov. 29 at his home in Brooklyn. Mr. Woodward was prominently connected with railway building in Illinois, with the clearing of the Savannah River of obstructions after the Civil War, and with the building of a canal at Keweenau Point in Northern Michigan. He was 84 years old at the time of his death.

Mr. W. N. PETTRICK, late of New York City, has been appointed Assistant Managing Director of the Imperial Chinese Railways, by the Viceroy, LI HUNG CHANG. Mr. PETTRICK will control the working staff and the ordinary business of the Tien-Tsin railway. The Engineer-in-Chief and Superintendent of the same system is Mr. C. W. KINDER, a member of the American Society of Civil Engineers, but an Englishman by birth.

Mr. WILLIAM C. ALLISON, founder and late President of the Allison Manufacturing Co., Philadelphia, died at his home on Nov. 30. Mr. Allison was born in 1817 at Uwchlan, Pa., at the age of 19, began business for himself in Philadelphia as a wheelwright. Since 1851 Mr. Allison has been engaged in car-building and other industries, having organized the firm of W. C. Allison & Sons in 1868, which was reorganized as the Allison Manufacturing Co. in 1881.

Mr. JOHN BOGART, whose term as State Engineer expires Dec. 31, will, it is unofficially announced, be appointed on that date Chief Engineer of the Rapid Transit Commission, vice Mr. WM. E. WORTHEN, who was lately appointed Consulting Engineer instead of Chief. Mr. BOGART was one of the four consulting engineers, it will be remembered, who reported on Messrs. WORTHEN's and PARSONS' plans, approving certain features of each but chiefly Mr. WORTHEN's plans.

Col. SAMUEL H. LOCKETT, who lately died in Bogota, Colombia, while acting as Chief Engineer of the new aqueduct of that city, has been the subject of highly complimentary notices in the papers of that city. His services were so much appreciated by the Aqueduct Company that the directors ordered his pay continued for some time after his death, and gave Mrs. LOCKETT the sum of $500 to pay her expenses back to New York. Doctor PERRA, City Engineer and assistant to Colonel LOCKETT, is to continue the work at the special request of his late chief.

NEW PUBLICATIONS.

—*December Magazines.* The literary magazines this month are filled with matter appropriate to the holiday season, and have practically nothing in the way of technical or scientific articles. The reviews, too, have little matter of special interest from an engineering standpoint, being just now filled with political discussions. Two excellent articles on competition and railway rates are found in the *Forum* and the *North American Review*. Chairman ALDACE F. WALKER, of the Western Traffic Association, in the former magazine shows that unregulated competition is self-destructive, and that the saying "Competition is the life of trade" is no truer than its converse, that competition is the death of trade. The practical application of this economic law is made by Gen. HORACE PORTER in the *North American Review*. He shows that the Inter-tate Commerce law, which attempted to increase competition between the different railways by prohibiting pooling, has done more than its makers intended. It has so stimulated competition that the weaker roads are being driven to the wall and forced into consolidations, which put an effective and permanent end to the struggle for traffic. The *Review* also has a paper by CARROLL D. WRIGHT describing the statistical investigation into the cost of living, prices of commodities, average rates of wages, cost of production, &c., undertaken by the Senate Finance Committee, in connection with the Labor Bureau, the Agricultural Department and some other government bureaus. We have already published some of the results of this inquiry. *The Popular Science Monthly* has an article by P. D. Ross on type casting machines, showing that these labor saving machines have now been perfected to a point where their use is economical and advisable in any printing office of considerable size. The mechanical type setters have come into limited use, but do not seem able to compete with the type-casting machines on the whole. In the excellent series of articles on the Development of American Industries since Columbus, this month's instalment sketches the rise of the pottery industry. The story is well told by Mr. EDWIN ATLEE BARBER; but its interest is artistic rather than mechanical.

—*The Practical Telephone Handbook* and Guide to the Telephone Exchange. By JOSEPH POOLE, Chief Electrician Lancashire and Cheshire Telephone Exchange Co. London: Whittaker & Co.; New York: Macmillan & Co. 12 mo., pp. 288; 227 illustrations; 75 cts.

This is in the main a very good, practical and complete manual of telephone practice, as also a remarkably cheap one. Few books of its style and class reach our table which are sold at less than $1.25 to $1.50. Most of the engravings are execrable from an artistic standpoint, being mere photo-reproductions of coarse newspaper impressions; but in their substance they are well selected, abundant and sufficiently clear. A defect of the book is that it takes space to describe too many minor devices which are not, and never have been, and are never likely to be, in general use. There are numbers of such devices in Europe which have never extended beyond the particular line which gave them origin. Throughout the book European practice is much better represented than American, and in fact for anything which appears in the volume one would never dream that the telephone was an American invention at all, nor so much more widely used here that all the telephones in existence outside of this country are but a small percentage of those within it.

This may be a mere accident, but it is not a little curious that the only inventor named in the book who is given a local habitation and a (full) name is Prof. HUGHES "of London," who is perhaps given overmuch credit as the original inventor of the principle of all modern transmitters. "Prof. GRAHAM BELL" is credited with the invention of the "first practical instrument," and "Prof. E. GRAY" is credited in five lines with having "on the same day that BELL filed his patent filed one with similar suggestions for producing variations in the resistance of an electric circuit. The apparatus employed by the two inventors for this purpose were almost identical."

This last quotation contains as many errors as lines. One would think that in a good sized monograph of this kind care might have been taken at least to state correctly Prof. "E. GRAY'S" connection with first development, since a great many people (among whom we must be numbered) believe that he and not BELL was the actual first inventor, and that he was unjustly robbed of his invention, by the unlawful disclosure to BELL of the secrets of the Patent Office. Professor GRAY first filed a caveat, and not a "patent" (in fact we do not know how any one can "file a patent" under the law). This filing was not "on the same day" but many weeks before BELL filed anything on the subject; and when BELL did file his "patent" for a telephone it was not in the form of an original application, but of modifications of a previously filed application for a quite different device. This last application, it is true, was filed just two hours (if we remember correctly) before GRAHAM'S caveat was filed, but that the latter was the first description ever filed in the Patent Office of a practical working telephone is now hardly disputed or disputable.

—*Report of the Commissioner of Labor.* Cost of Production, Iron, Steel, Coal, &c. Part 3. Cost of Living. CARROLL D. WRIGHT, Commissioner. 8vo., pp. 800.

This tremendous report, the first two parts of which we have already noticed, is divided it to parts as follow: I. Cost of production. II. Wages and the efficiency of labor in the industries named. III. The cost of living of families whose heads are employed in the industries named. The report in full comprises no less than 1,404 pages. All this space is occupied by details relating to the Iron industry alone. The Commissioner's seventh annual report, which is to be transmitted to Congress early in the coming session, will treat in a similar way the textile and glass industries. If all industries are to be taken up in succession and discussed with equal minuteness, the Commissioner's reports will soon become a library in themselves. We fear that this elaboration may defeat the very end in view by discouraging would-be students, but nevertheless the government has seldom issued reports which are such monuments of patient and discriminating care as are these. If any one cares enough about facts to dig for them he can find them in these reports as they can be found nowhere else, and when he has once dug down to the right spot he will find the particular facts which he wishes to know, already worked out and before his eyes, whatever those facts may be, if within the scope of the volume.

We are pleased that there seems to be no call upon us to review in detail the facts given in this last part, on cost of living, but the earnings and expenses of 2,490 families of 19 different nationalities living in the United States, and of 770 families living in 9 European countries, are divided and subdivided with great minuteness, and tabulated and retabulated according to industries, &c., &c. Two lines out of the last two pages of the work perhaps come the nearest of any to giving the pith of the investigation, viz., the averages for *all* the 2,490 families living in the United States and for the 770 families living in Europe. We add, however, still a third line giving the averages for the 293 families living in England and obtain he following:

	Families. No.	Av. size.	Own. house.	Expenditure per family for Rent.	Food.	Other.	Total.
U. S.	2,490	5.0	540	$74.58	$243.65	$254.50	$555.81
Europe.	770	5.3	31	41 76	222.52	175.40	439.83
English.	293	5.1	7	50.20	224.81	187.12	460 93

	Income per family from Husband.	All sources.	Balance per family. Surplus. Families.	Surplus. Average.	Deficit. Families.	Deficit. Average.
U. S.	$534.53	$622.14	1,580	$137.87	869	$60.59
Europe	368.30	470.16	441	69.52	167	30.85
English.	416.92	496.75	179	62.07	26	23.67

It will be seen that expenses run slightly higher in the United States, but in no such degree as the style of living of the American workman exceeds that of the European. Income on the other hand is considerably higher here, by 25 to 30%, but in no such degree as one would have expected, or as would actually obtain in the higher grades of employment, we imagine.

—*Report of the Chief Inspector of Mines of Ohio*, for 1890. ROBERT M. HAZELTINE, Chief Inspector; Columbus; O.; 8vo.; pub. dcc.; pp. 278.

This report is certainly an admirable record of what appears to be faithful work. One of the tables in the report we have abstracted and commented on editorially. Another on the use of electricity in mines contains some valuable records which every mining man will do well to examine.

—*The Eleventh Census.*—An address by Hon. ROBERT P. PORTER, Supt. Census, before the American Statistical Association. 8vo., pamph., pp. 64.

This address gives a very interesting summary of the work of the Census Bureau, and of the working of the electrical tabulating machines. It is announced that a bill for the permanent organization of the Census Bureau will be laid before Congress at the coming session, as called for by a resolution of the Senate.

—*Portfolio World's Columbian Exposition*, 1893, illustrated by C. GRAHAM. This is a very handsome advertising pamphlet issued by the Winters Art Lithographing Co., Rookery Building, Chicago. The illustrations are copies of water colore drawings, and show four different groups of buildings in 15 illustrations. A very complete description accompanies each illustration. The pamphlet can be had for 50 cents by addressing the lithographing company as above.

TRADE PUBLICATIONS.

—*Railway Car Trimmings*, Chairs, Seats, Curtains, &c. The Adams & Westlake Co., Chicago, 1891. Cloth, 9¼ × 12 ins., pp. 429.

The revolution which has been wrought in the building hardware trade since the fact became generally recognized that artistic appearance and finish is the most important factor in determining the price at which these goods are salable is an excellent example of the progress in art, or in the appreciation of art which this country has made in the past few years. To realize the great improvement which has been made in car builders' hardware during the past few years, one has but to turn over the leaves of the book before us. The index alone to this catalogue

occupies 6¼ pages, and the matter in the book is almost wholly illustrations and prices. The former are all wood cuts and are very well engraved and finely printed. As for the prices, we are assured by the New York representative of the Adams & Westlake Co. that a new departure has been made in this regard. In the average catalogue nowadays the prices given are purely nominal, and may be double or triple those at which the goods can be bought; but in compiling this book great pains has been taken to make the prices accurate and reliable, so that a car builder or designer can make out his bill of hardware in estimating on a car with some confidence that he is close to the mark.

The variety in hardware shown is remarkable. For example, we count no less than 108 different patterns of sash lifts, all of which are furnished either in brass, bronze, oxidized, nickel plated or silver plated, and at prices varying from 10 cts. to 75 cts. each. There are also 85 styles of blind lifts. In fact everything in hardware needed for the trimming of the most elaborate parlor car or the cheapest emigrant car may be found in this catalogue; and we believe car designers will find it one of the very best books of its class for reference in their work.

SOCIETY PROCEEDINGS.

Central Railway Club.—At the meeting on Nov. 25 the report of a special committee on wheel gages and wheel defects was presented by Joint Inspector J. R. Petrie. The report recommended an alteration in the wheel defect gage to allow wheels to run with sharp flanges which are not worn vertical or to such an extent as to make them unsafe. Discussion of the report was deferred until the next meeting, and the committee was instructed to make any further recommendations with regard to the radius of the defect gage that might be suggested as a result of consultation with the members.

Mr. A. M. Waitt, chairman of the special committee on "Wrong Drawbars," then presented the following report:

There is perhaps no one class of defects or wrong material met with in car interchange in connection with which there is such a diversity of opinion and practice among inspectors as the subject of wrong drawbars. It is doubtless a fact that there are hardly two railroad companies in the United States which are using the same style and size and shape of link-and-pin drawbars. Each road clings tenaciously to its own particular shape as being just a little superior to any other; but they are all of a style which has by the general vote of the M. C. B. Association been superseded by a superior type of coupler, which is in its highest type automatic, and does away with the link and pin, which is such a large source of expense at present on our respective lines.

In the opinion of your committee everything consistent should be done to further the adoption of all recognized standards adopted by the M. C. B. Association; and the perpetuation of styles of equipments at variance with such standards should be avoided and discountenanced by all who have the best interests of railroad management at heart. The M. C. B. Association having adopted the vertical plane coupler of the M. C. B. type as their standard, and as it now stands before the country as the safest and best type in use, and as all state legislation of the past few years and the recommendations made to Congress point toward the compulsory use on all cars of couplers of this type, we believe that one of the most important needs of the present time is to adopt and use only the best styles of the above coupler and to consign to oblivion the many devices in this type of coupler that are not worthy to be perpetuated.

As a large portion of the present older equipment of the country is fitted still with the link-and-pin coupler, it becomes necessary for the present, as a matter of justice, to consider the best way to handle the replacements of such drawbars as become broken, without wronging the companies owning the cars. We find the link-and-pin draw bars differing from one another in three different ways, each of which may have a proper claim for recognition.

1. Different materials of which drawbars are made, as cast, wrought and malleable iron, and steel.
2. Different dimensions and weight of drawbars.
3. Different methods of securing back end of drawbar to the draft rigging, as by a spindle or pocket strap, or continuous coupling rods.

Each of the above classes of differences is such as concerns the cost and strength of the parts, and should be given recognition in interchange; but your committee can see no possible advantage of each road perpetuating in its own cars the particular detail of curves and angles and minor dimensions of its drawbars, provided that in the place of a broken one a drawbar is substituted corresponding in material, general dimensions, method of attachment, to the one removed. We also believe in the matter of dimensions that the only essential features are that the bars should correspond, in (1.) Length from end of head to first follower plate, but permitting use of a bar not over 2 ins. longer than the original. (2.) Depth and width at outer yoke in carrier iron, permitting each to be one-fourth larger or smaller than original. (3.) Length and width of pocket and size of iron forming pocket. (4.) Diameter and length of spindle.

In conclusion we would recommend the adoption as the sense of this club, and the practice by the members of this club and such others as may be willing to do so, of the following rules in regard to wrong drawbars:

Hereafter in the interchange of cars with connecting roads, cars having "mixed" or wrong drawbars will be received without a defect card, if they are in good condition and fit properly, except in the following cases:

1. Cars having an M. C. B. standard drawbar replaced by one of a different type.
2. Cars having a link and-pin drawbar replaced by one made of different material.
3. Cars having a link-and-pin drawbar replaced by one having a different method of attachment to draft rigging.
4. Cars having a link-and-pin drawbar replaced by one of essentially different dimensions and weight.

In each of the above cases an M. C. B. defect card may be required from the delivering road covering the wrong drawbar, the card to show in what general manner the replaced drawbar differs from the original which was in the car. We would further recommend that this Club forward these rules to the proper committee of the M. C. B. Association as the sense of this Club, and recommend that they be incorporated in the M. C. B. rules of interchange at their next revision.

There was an extended discussion on this report. Messrs. Adams of the Boston & Albany and Chamberlain of the Boston & Maine opposing the M. C. B. coupler and the members of the Central Ry. Club defending it. The arguments of Adams and Chamberlain were chiefly repetitions of those which they have presented at former meetings of this and other clubs, opposing the M. C. B. coupler on the grounds of expense and danger. In reply President Eugene Chamberlain, of the New York Central, said that fully 70% of the breakage was due to the use of link-and-pin drawbars in connection with M. C. B. couplers. Mr. Waitt did not know of a single case of personal injury where all equipment had the M. C. B. type. Mr. Miller said the M. C. B. coupler had come to stay; there was no doubt on that point. The trainmen on his road were satisfied with the M. C. B. type; and if no other were used, there would be no trouble. Mr. Macbeth said that the Adirondack & St. Lawrence had about 500 cars equipped with M. C. B. couplers which had been heavily loaded and subjected to severe service. In 6 months' time they had broken only 5 knuckles, and he did not know of a single case of personal injury. He believed in helping the M. C. B. Association in its efforts to get rid of other kinds of couplers. Mr. Mackenzie said that incontrovertible evidence could be produced to show that where improved couplers, draw timber, &c., are used together, personal injury or broken drawbars will be impossible. Mr. West said that 60% of the New York, Ontario & Western cars have M. C. B. couplers, and 90% of the breakage is the result of yard work and link-and-pin couplers. The recommendations of the committee were unanimously adopted.

The committee on "worn out brake shoes," Peter Smith, Robert Potts and A. Dolbeer, reported that the M. C. B. rule requiring the replacement of brake shoes ⅝ in. or less thick at the center, does not cover all cases of wear. A large number of shoes wear tapering on bottom and top ends, endangering the wear of the heads, and shoes also wear one-sided. The latter class should be condemned, as they interfere with the efficiency of the brakes. The committee does not favor turning them, as this would bring the bearing on the throat of the wheel, and perhaps injure or destroy the wheel.

The next meeting will be held on Jan. 27 and will be followed by a banquet, to which ladies will be invited.

Western Railway Club.—At the meeting on Nov. 17, the paper by Mr. J. N. Barr detailing experience with boiler compounds on the Chicago, Milwaukee & St. Paul was discussed. The paper and discussion are abstracted in another column. President P. H. Peck read a paper on Master Car Builders' Standards and Defect Cards. The great trouble with the M. C. B. standards is that they are confined chiefly to a few truck details. The whole car and every part of it should be standard. One important reason for the air brake's success is its absolute uniformity. The great defect in the M. C. B. standard couplers is their lack of uniformity. Some of them are bad; none of the knuckles will interchange; and the unlocking devices are all different. Train and switchmen are generally in a hurry, and especially in the night are often unable to tell which way to move the coupling lever to unlock the coupler. A steel knuckle costs as much as an ordinary cast-iron drawbar, and to promote the general adoption of the coupler the knuckles ought to be interchangeable. There is no occasion for such diversity among the M. C. B. couplers. Of 19 different makes, 14 can be uncoupled with a shaft placed across the end of the car above the coupler.

Defect cards serve an important use; but they are often made out too carelessly. Many inspectors make out a card for "mixed drawbars" when one bar on a car is broken and replaced with a different one. By and by the other of the original drawbars is broken and a still different one is put in its place; but the same card passes the car along until it reaches the home road, when of course it is refused, both drawbars being wrong. Among other evils are the delays caused by the fact that many inspectors have no authority to card cars without permission from their foreman, and the great variation in the prices charged for work done in repairing foreign cars. The interchange rules should be amended to cover this last matter.

American Society of Civil Engineers.—At the regular monthly meeting, Dec. 2, Mr. J. A. L. Waddell read an interesting and valuable paper on "Some Disputed Points in Railway Bridge Designing," of which we shall next week publish a full abstract. The paper is of such length that we are unable to give proper space to it in this issue. Mr. Waddell took a strong position in favor of uniform loads instead of engine wheel load concentrations, and in favor of assuming ample loads in proportioning bridges. The paper was discussed by Messrs. Seaman, Breithaupt, Du Bois, T. C. Clarke, Blakeley and others.

An opposition ticket was submitted by 12 to 14 Western members, headed by President Chanute and ex-President Whittemore, nominating D. McN. Stauffer for Treasurer, the ticket being otherwise the same as the regular ticket.

Engineers Club of Philadelphia.—Business meeting of Nov. 21. Mr. Howard Murphy, for over ten years the energetic Secretary of the club, resigned owing to a press of personal business engagements. The resignation was accepted by the Board of Directors and a resolution was passed testifying to the good services of Mr. Murphy and expressing regret at his resignation. Mr. John C. Trautwine, Jr., was appointed Secretary to fill the unexpired term, and he resigned from the Board of Directors accordingly. The discussion of the paper of Mr. W. W. Thayer on "Street Paving" was continued and Mr. R. W. Lesley presented a paper on "Purchasing Cement for Large Works." Smoke prevention or abatement in cities is selected as the subject for the next meeting on Dec. 5.

HOWARD MURPHY, Secretary.

Southern and Southwestern Railway Club.—At the meeting on Nov. 19 at Atlanta Mr. F. A. Charpiot, of Macon, Ga., was elected secretary. The constitution was amended, fixing Atlanta as the regular place of meeting, and the third Thursday in January, April, August and November as the dates of meeting. A paper on "Uniformity in Locomotive Performance Sheets" was read by Mr. Jas. Meehan. The secretary was instructed to collect the forms of record now in use by different roads for the purpose of compiling a uniform sheet. At the next meeting the subjects proposed for discussion are methods of hanging inside brakes in freight car trucks, setting flues, and size, shape and fastening of draft timbers.

Civil Engineers' Club of Cleveland.—At the meeting on Nov. 10 two reports on the last visiting day were read, one by Mr. E. P. Roberts on the Power House of the Broadway & Newburgh Street R. R., and the other by Mr. Geo. E. Gifford, on the Cleveland Rolling Mill Co.'s plant. The paper of the evening was by Prof. Frank H. Neff, on French Roads—their Administration, Construction and Maintenance. It contains an elaborate and detailed account of how these celebrated roads were constructed, their cost, the way in which they are kept in repair, and the care and pains taken to maintain them in their present high state of excellence.

New England Water-Works Association.—The regular quarterly meeting will be held at Young's Hotel, Boston, on Dec. 9. Rooms will be opened for the use of members at 10:30 A. M. Lunch will be served at 1 P. M., tickets $1.50. At 2 P. M. a paper will be read by F. P. STEARNS, Chief Engineer Massachusetts State Board of Health, on "Selection of Sources of Water Supply." General discussion will follow.

R. C. P. COGGESHALL, New Bedford, Mass., Secy.

Northwest Railway Club.—At the meeting Nov. 7 a paper was read by Mr. C. A. Seley on "Boiler Inspection," and one by Mr. J. P. Seymour on "Paints—Their Composition and Purity." Abstracts will be given in our next issue.

Rensselaer Society of Engineers.—At the meeting on Nov. 20, the president, Mr. O. F. Nichols, addressed the members on "The Student Life of an Engineer."

Canadian Society of Civil Engineers.—Ballots for officers for 1892 were submitted at the last meeting as follows: For president, Messrs. John Kennedy and E. P. Hannaford; for vice-president (2), Messrs. P. A. Peterson, W. T. Jennings, Thomas Munroe; for treasurer, Mr. H. Wallis; for secretary, Prof. C. H. McLeod; for librarian, Mr. C. W. McNab.

Liverpool Engineering Society.—Meeting of Nov. 11, President Mr. John T. Woods in the chair. A paper on "Screwing Cast Iron and Driving Greenheart Piles at St. Anne's-on-the-Sea, Lancashire," was read by Mr. John J. Potts, Assoc. M. Inst. C. E. These notes were taken during the reconstruction and completion of the jetty (of which the piles form a portion) for the landing of passengers from excursion steamers, situated at the outshore end of the promenade pier at St. Anne's. Borings on the site showed that hard clay lay under from 8 to 11 ft. of compact sand and gravel. The screw piles, which are all open hollow cast iron tubes, with screw blade at the bottom end, 3 ft. diameter and 6 ins. pitch, were screwed through the sand and gravel into the hard clay. A description was given of the gear employed and the precautions taken, it being tide work, for getting both the upright and raking piles to the required depth; also particulars of the mode of working, the number of men necessary for each arrangement of the gear, the time spent in screwing, the rate of progress, and the power developed in screwing the piles down. Owing to the nature of the foreshore it was arduous work screwing the piles in place, and the difficulty was increased when the capstan had to be reduced in diameter on account of the existing columns in the original structure being in the way.

The piling engine for driving the greenheart piles was of the usual construction, the hip being of cast iron and weighing 19½ cwts. Particulars of the mode of working and of the behavior of the piles during driving, with the precautions taken for preventing the piles splitting, twisting, &c., the time occupied in driving and the number of men employed, were also given. These piles being driven from above high water level, after only being pitched, it was not such tedious work as with the screw piles.

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AND

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COMING TECHNICAL MEETINGS.

Civil Engineers' Society of St. Paul.—Dec. 7. Secy., C. L. Annan.

Engineers' Club of Kansas City.—Dec. 7. Rooms, Baird Building. Secy., H. Goldmark.

Atlanta Society of Civil Engineers.—Dec. 8. Secy., Parker N. Black, Room 89, Capitol Block.

Denver Society of Civil Engineers.—Dec. 8. Secy., Geo. H. Angell.

Northwestern Society of Engineers.—Dec. 8. Rooms, Occidental Block, Seattle. Secy., E. H. Warner.

Civil Engineers' Association of Kansas.—Dec. 9. Secy., J. C. Herring, Wichita, Kan.

New England Railroad Club.—Next meeting, Dec. 9. At United States Hotel, Boston. Secy., F. M. Curtis.

New England Water-Works Association.—Dec. 9, Young's Hotel, Boston. Sec., R. C. P. Coggeshall, New Bedford, Mass.

Civil Engineers' Club of Cleveland.—Dec. 11. Secy., A. H. Porter, 50 Euclid Ave.

Engineering Association of the Southwest.—Dec. 11. Secy., O. H. Landreth, Nashville, Tenn.

Northwestern Track and Bridge Association.—Dec. 11. Rooms, Union Station, St. Paul.

Western Railway Club.—Dec. 15. Rooms, Rookery Building, Chicago. Secy., W. H. Marshall.

Engineers' Society of Western Pennsylvania.—Dec. 15. Secy., J. H. Harlow, Pittsburg, Pa.

Engineers' Club of St. Louis.—Dec. 16. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

American Society of Civil Engineers.—Dec. 16. Secy., Francis Collingwood, 127 East 23d St., New York.

Boston Society of Civil Engineers.—Dec. 16. Secy., S. E. Tinkham, City Hall.

Canadian Society of Civil Engineers.—Dec. 17. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.

Engineers' Club of Cincinnati.—Dec. 17. Secy., J. F. Wilson.

New York Railroad Club.—Dec. 17. Rooms, Gilsey House.

Scandinavian Engineering Society of Chicago.—Dec. 17. Secy., T. G. Pihlfeldt, 118 Adams St.

Montana Society of Civil Engineers.—Dec. 19. Helena.

Engineers' Club of Philadelphia.—Dec. 19. House, 1122 Girard St. Secy., John C. Trantwine.

Technical Society of the Pacific Coast.—Jan. 1. Secy., O. von Geldern, 819 Market St., San Francisco.

Swedish Engineers' Club.—Jan. 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.

Northwest Railroad Club.—Jan. 2. Rooms, Union Station, St. Paul.

Western Society of Engineers.—Jan. 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of Minneapolis.—Jan. 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Association of Civil Engineers of Dallas.—Jan. 8. Secy., E. K. Smoot, 806 Commerce St.

WE received recently from one of our correspondents the following letter of inquiry, which we reproduce verbatim, except that we substitute initials for the various names given:

GENTLEMEN: Will you be kind enough to tell me if the A. B & C. road is now under construction between D. River and E. Springs, and if the work is completed in F Co., and if the G. branch is under construction. I will also be obliged for any information in regard to the H. Creek extension to the K. State line. Who are the contractors? Who has the work on the O. V. Railroad, and in what county are they working, and about what time is the work supposed to be completed? Would be glad for any information in regard to work now under construction in the State of L.

We forbear to draw the moral. By taking time enough we could probably have given our correspondent most of the information he asked for, but we trust that when he sees his letter in print he will understand, without further explanation, why his letter elicited no other response than this.

IT is easy to be wise after the event, which makes it all the more foolish not to be so then, if not before. Water-works engineers will be neglecting an unusual opportunity if they do not store away in their memory a few lessons from the Brooklyn disaster, described in our last issue, among which are these:

1. Total stoppage of the water supply of a city, and especially of a large city, is a serious matter. It is well to be correspondingly prepared for it. Hence—

2. Reliance upon a single conduit for supply is an unpleasant necessity, to be avoided whenever, or as soon as, circumstances permit. Hence—

3. A second conduit, when constructed, should, if possible, be kept far enough away from the old one to avoid all chance that an injury to one may result in injury to both. Or, if that be impossible—

4. A second conduit should at least be so far removed that the work of constructing the new conduit will not endanger the old one. Or, if that be impossible—

5. The old conduit should not have the pressure on its sides relieved and on its crown largely increased at one and the same time. Breakage may occur, and therefore—

6. It is unwise to be caught with only 1¼ days' supply available when storage capacity for six days exists. But if, unfortunately, one should be caught—

7. It is unwise to let consumption go on as usual until the supply is almost exhausted, in hopes that the break may be repaired meantime, and then have the supply give out wholly. Instead thereof—

8. It is well to be prepared in advance for a break in a solitary water conduit, as for a fire at sea, at least to the extent of having a well understood program in outline for such contingencies; and this program should, before all other things, include *immediate* curtailment of supply, so as to make it hold out during the *maximum* period which may be required for repairing the break.

Perhaps a lesson as to the danger of relaxing vigilance toward the end of a heavy piece of construction might also be deduced from the accident.

THE report of the Statistician of the Interstate Commerce Commission reaches us too late in the week to permit of a proper summary of its many interesting points, but in two obvious respects it deserves only condemnation: First, in waiting until December, 1891, to publish operating statistics for the year ending June 30, 1890, and, secondly, in trying to remedy this tardiness by publishing tables of earnings and expenses for the nine months ending with March 31, 1891. Statistics for parts of a year have their proper and useful place, but no one wants statistics for nine months only embalmed in permanent form, especially if it is necessary to wait till they are eight months old to get them. Of course the effort is to bring the statistics down to the latest possible date consistent with having a report ready for the opening of Congress; but if it be not possible to have statistics ending with June 30 ready to present at the opening of Congress in December, Congress is easily capable of restraining its impatience for the statistician's report until a few weeks after the opening, if by so doing it can obtain reports for 12 months, instead of 9 months. And if it is necessary that such statistics wait until they are *two years* old before they are published (for two years is their mean age), they might almost as well not be published at all. Few of the men who would otherwise derive profit from these reports will consent to go back so far into ancient history for information. We trust that, as is implied in the report, the delay is exceptional, and due in part to a marked step in advance, namely, the subdivision of the United States into 10 different geographical groups, instead of merely adding together *en masse* the statistics for the entire country.

THE last report of the Chief Inspector of Mines of Ohio contains a little table which brings out in strong light a certain frightful uniformity in the loss of life from coal mining, which in all states and countries seems to run at the rate of about one human life and perhaps three serious but not fatal injuries for every 200,000 tons of coal got. Rudely "equating" the injuries it may be said that every 100,000 tons, or thereabouts, costs a life or its equivalent. The following is a condensation of the part of the table relating to fatal accidents:

NUMBER OF THOUSANDS OF TONS OF COAL MINED PER FATAL ACCIDENT.

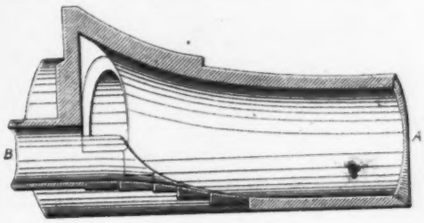
	1886.	1887.	1888.	1889.	1890.
Pennsylvania.	175	169	167	150	..
Illinois.....	178	245	216	276	238
Ohio.....	194	286	376	331	281
Iowa.....	183	227	177	98	..
Kentucky.....	236	..	155	156	233
Indiana*.....	429	..	..	..	..
West Virginia*....	..	..	192	..	..
Kansas*.....	..	224	..	..	..
Colorado*.....	..	149	75	..	..
Missouri.....	..	..	150	222	243
Nova Scotia.....	..	259	888	219	220
Great Britain.....	165	163	191	178	..
Average*.....	222	221	290	204	243

*The figures for Indiana, West Virginia, Kansas and Colorado *are neglected* in computing the average, since they are given for only one or two years and are for relatively small quantities of coal.

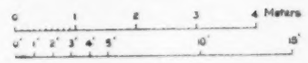
The tendency to improvement in the past five years is not discernible by the naked eye. The British mines show the worst upon the face of the returns, as is natural from the nature of their mines, but taking due account of the latter, their record is probably the best. The Continental mines show even worse than the English. Both in England and here there has been no small improvement in the past 20 years or so, as the following figures will show:

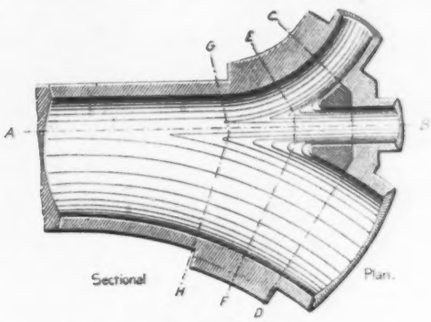
Thousands of tons per death in Great Britain.....	1871-5 122	1886-9 174	Dec. p. c. 30%
	1874-7	1886-90	
Ohio.....	189	283	31%

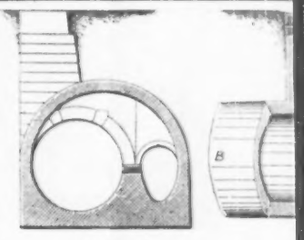
But as a whole coal mining still remains a frightfully dangerous occupation, and for the most part unnecessarily so; that is to say, a very small additional expenditure in getting the coal would suffice to save more than half the lives. As the coal product of the world is now rapidly approaching the even figures of 500,000,000 tons per annum, it will be seen that the present death rate means that some 2,500 miners per year must suffer death, and 5,000 to 7,500, grave injuries. If we call the coal worth $2 per ton at the pit's mouth, a life or its equivalent is sacrificed for every $200,000 worth of product, on which the profit to the operator may be $20,000. It is at once clear that, while the world could and would gladly pay 5% more for its coal to save these lives, it means loss of half profits for any individual operator to try to save his share of them at that price, if the burden be not laid uniformly on all. Hence a lack of individual enthusiasm, and need for vigilant public control.



Section A-B.





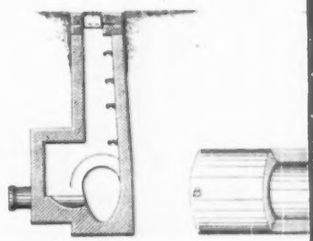


Section C-D.

Connection of Egg-

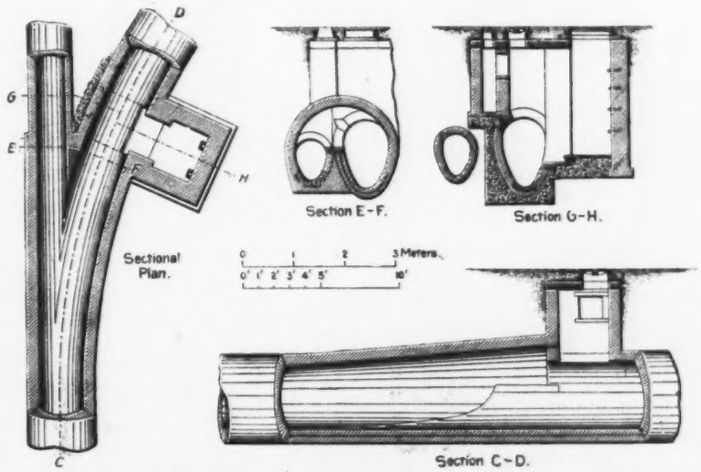
Section G-H. Section E-F. Section C-D.

Connection of Two Egg-Shaped Sewers 0.90 m. × 0.60 m., with Circular Sewer 2.00 m. dia.

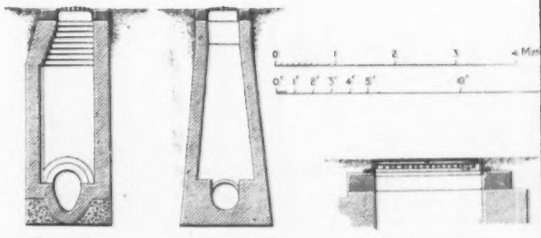


Section C-D.

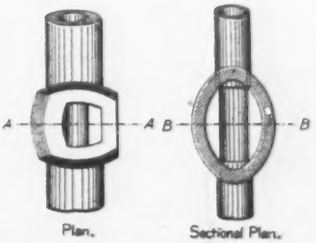
Connection of Circ



Connection of Egg-Shaped Sewers 0.90 m. × 0.60 m. and 1.20 m × 0.90 m.

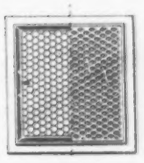


Section A-A. Section B-B. Section.



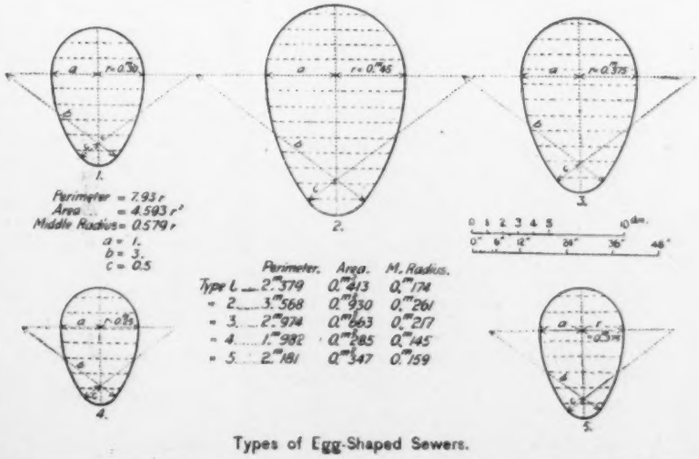
Plan. Sectional Plan.

Manhole for Egg-Shaped Sewer. Manhole for Circular Pipes.



Plan.

Cover for Manhole with Side Entrance



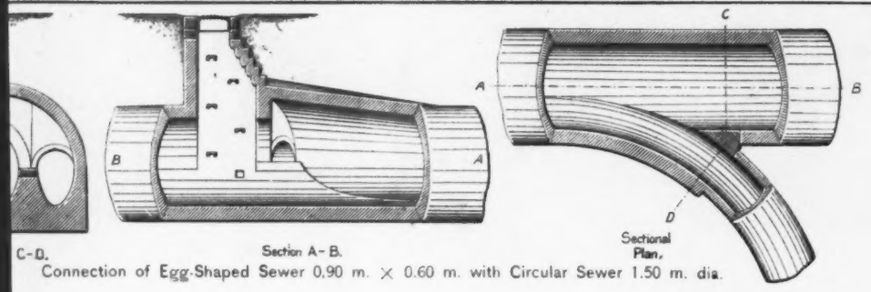
	Perimeter.	Area.	M. Radius.
Type 1.	2.m579	0.m²413	0.m174
" 2.	3.m568	0.m²930	0.m261
" 3.	2.m974	0.m²663	0.m217
" 4.	1.m982	0.m²285	0.m145
" 5.	2.m181	0.m²347	0.m159

Types of Egg-Shaped Sewers.

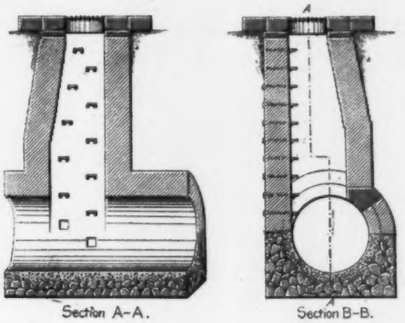
THE NEW DRAINAGE W

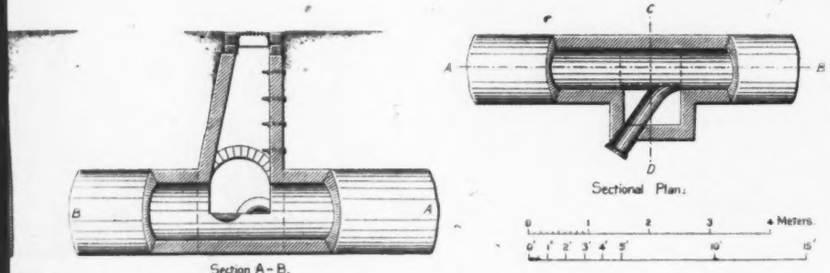
ADOPTED TYPES

ROBERTO

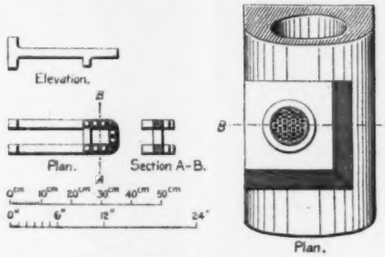


Connection of Egg-Shaped Sewer 0.90 m. × 0.60 m. with Circular Sewer 1.50 m. dia.

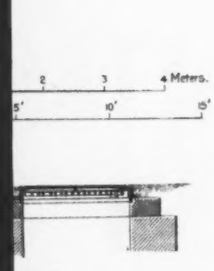


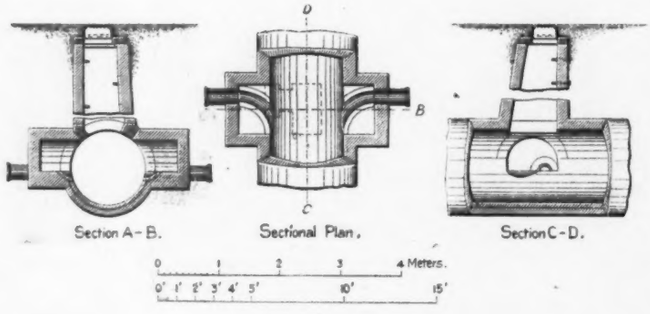


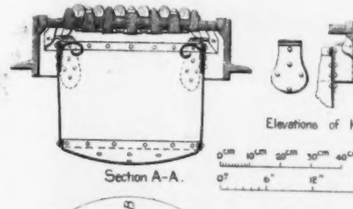
Connection of Circular Sewer 0.30 m. dia. with Egg-Shaped Sewer 1.10 m. × 0.80 m.

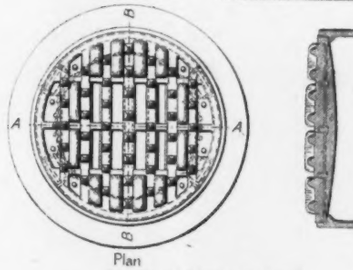


Details of Manhole Steps. Manhole for Circular Sewer.

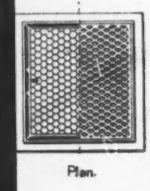




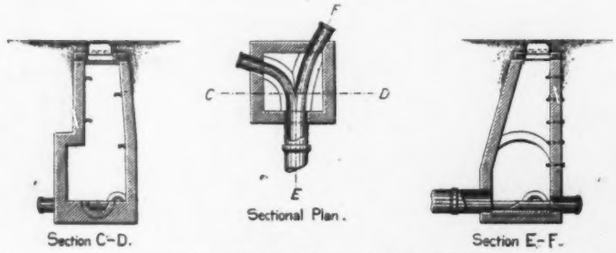




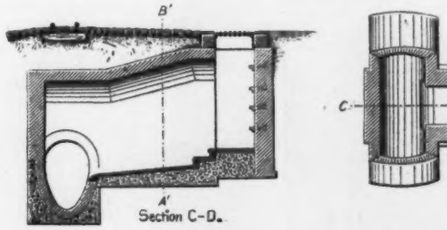
Details of Manhole Cover with Catch Bucket.



over for Manhole
th Side Entrance.



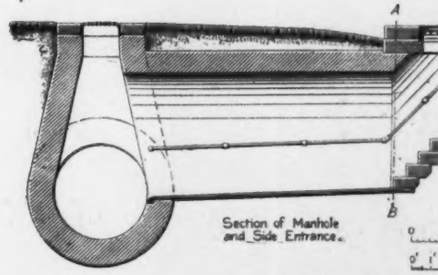
Connection of Pipe Sewers and Main Sewer.



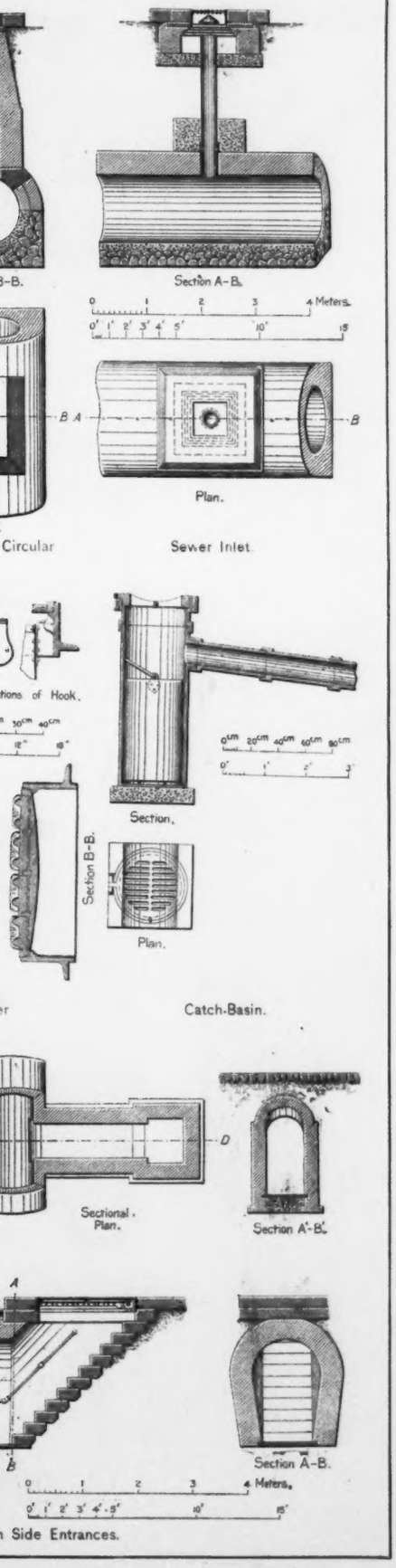
DRAINAGE WORKS OF THE CITY OF MEXICO.

ADOPTED TYPES OF STRUCTURAL DETAILS.

ROBERTO GAYOL, CITY ENGINEER.



Manholes with Side En


B-B.
Section A-B.
0 1 2 3 4 Meters.
0' 1' 2' 3' 4' 5' 10' 15'
B A
B
Plan.
Circular
Sewer Inlet.
tions of Hook.
0cm 20cm 40cm 60cm 80cm
0' 1' 2' 3'
Section.
Section B-B.
Plan.
er
Catch-Basin.
D
Sectional Plan.
Section A'-B'.
A
B
Section A-B.
0 1 2 3 4 Meters.
0' 1' 2' 3' 4' 5' 10' 15'
n Side Entrances.

OUR English contemporary, the *Engineer*, has fallen into another of those little oversights in regard to things American which from time to time ornament its columns, and which by a singular coincidence generally make to the disadvantage of things American. In its last issue it has a leading editorial on "Two Fast Trains." It remarks that "the process of 'breaking the record' is so dear to the souls of our American cousins that we shall not feel surprised if report after report reaches this country of the attainment of exceptionally high speeds. The latest announcement of the kind is" the new Empire State train of the New York Central, of the first day's run of which it proceeds to give details in the usual form and at some length. The speed of this train was, of course, as it has been every day since, substantially in accordance with its schedule, viz., 53 miles per hour excluding (4) stops, or 50¼ miles per hour including them, the distance being 440 miles, and the train weighing 178 tons behind the engine, or 278 tons in all. "On the whole," remarks the *Engineer*, "this is a very good performance, but it will be seen that the running speed is not exceptionally high," and continues:

We may now proceed *to compare this* [regular schedule] *with a trip* made Oct. 16 on the Chemin de Fer du Nord. The train consisted of 12 vehicles weighing 139 tons (of 2,240 lbs.), drawn by a new compound engine carrying 200 lbs. pressure, four 7-ft. coupled drivers, the engine weighing 43 tons, 30 on drivers, and the tender 28 tons, the total weight of the engine and tender being 71 tons or nearly 20 tons [actually 18.28 tons] less than the American engines of which we have just been speaking.

This train ran 184 miles (instead of 440) in 3h. 25 m., the actual velocity being thus over 53.3 miles per hour, which is a shade better than the "Empire State's" regular time. The *Engineer* continues:

The whole performance was admirable and proves that the engine is of unusual excellence. The ratio of the weight of engine and tender to train was about 51%. In the case of the American train it was 56.5%, and on the steepest incline, as we have seen, two engines were used. The facts go to confirm what we have often said, namely, that American rolling stock must be harder to haul than any on this side of the Atlantic or that the internal resistance of American locomotives must be abnormally great.

IF the *Engineer* had been very reluctant to be driven to these dismal conclusions from a comparison of an American *regular* train making a 440-mile run on a fixed daily schedule, with a single trial run of 184 miles of a new engine, it might have occurred to it that perhaps it would be fairer to compare special run with special run than special run with regular train, and an experimental run made Sept. 14 as a preliminary to the establishment of the new "Empire State" express might then have occurred to it; especially as that run attracted considerable attention throughout the world from the fact that 436 continuous miles were made in 426 minutes running time, *plus* 13½ minutes for stops, seven minutes of which was because of a hot box. But even if for any reason this trip had not seemed a pertinent or judicious one to note, it might have been not unreasonably expected of our contemporary, perhaps, to remember that as respects the comparative performance of engines the weight of the tender is really a part of the train, and should be so considered, at least before giving expression to low opinions of an engine's "internal resistance." Had this been thought of it would have appeared from figures given in the *Engineer's* own article that the ratio of weight of *engine only* to weight of train, and the ratio of weight on drivers to weight of train were both practically identical in the American regular and French special train, as the following comparison shows:

Ratio wt. on *drivers* to total wt. train, French special	$\frac{30}{278}$ = 11.3%
do do Empire State train	$\frac{30}{278}$ = 11.4%
Ratio total wt. *of engine only* to total wt. of train, French special	$\frac{71}{278}$ = 20.5%
do do Empire State train	$\frac{71}{278}$ = 21.6%

It will be seen that the alleged contrast of 51 and 56½ per cent. "goes to confirm" neither one of the *Engineer's* alternative conclusions. Finally, our contemporary rests its unpleasant conclusions in part upon the fact that "two engines were used on the steepest incline" to help the regular train up the heavy grade at Albany, whereas none was used to help the French special "up a steep bank of 1 in 133, about 2½ miles long," or about 100 ft. of lift in all! We will not trouble our contemporary with the exact figures of the grade and lift at Albany; it doubtless had looked them up before venturing on this comparative statement; but it is clear that it must have momentarily forgotten them while penning this comparison.

IMPORTANT action was taken at the last meeting of the Central Railway Club, as reported in another column, on the repair of drawbars on freight cars. The rapid increase in the weight of cars and length of trains has left the draw gear of the average freight car too weak for the work thrown upon it. As a consequence, a large percentage of freight car repairs are made on the draw gear, and to avoid delays of traffic and increase in shop expenses it is important that these repairs be made as quickly and economically as possible. But there are about as many varieties of the link-and-pin drawbar in use as there are railway companies in the country, and the nuisance of making or obtaining a drawbar exactly like a broken one is a very great one. Instead of this, the railways frequently prefer to put on whatever drawbar comes handiest, and send along the car with a "defect card" attached. When the car gets home, the "wrong drawbar," which cost the company putting it on the car perhaps 2½ cts. per lb., is credited to it as scrap at ¼ ct., and a new one is put in its place and charged to the company at full price.

It has been well said that the time and expense devoted to keeping these old link-and-pin drawbars alike on the two ends of a car would be much better spent in equipping cars with drawbars of the M. C. B. type. The Central Railway Club proposes to relax the protection which has been thrown around the link-and-pin bar. When one is broken it is proposed to allow it to be replaced with any other which is of the same material, which fits satisfactorily and which is attached in the same way to the draft rigging. There is little doubt that some change of this sort will be made, probably at the next M. C. B. convention. In fact a similar measure was near success last June at Cape May; but an inopportune amendment caused it to be dropped.

Concerning the repairs of the M. C. B. drawbars, the Central Club recommends that unless the new M. C. B. drawbar is of a different *type* from the one broken, the car shall be passed without a defect card. Just what this means is not quite certain, and some amendment and amplification of the rule will probably be necessary. For example, it can be maintained with equal truth that all M. C. B. couplers are of the same type, and that the Janney and the Gould are of different types. There is no doubt that it would be desirable to allow renewals to be made with some other makes of coupler than the one broken; but, on the other hand, to permit the replacement of a good M. C. B. coupler from reliable makers with a cheap one from a new rival in the field, would not do at all. Perhaps it might be feasible to leave this matter in the hands of the Executive Committee, and let them decide upon three or four makes of M. C. B. couplers to be universally accepted in interchange.

IN the race between the makers of armor plate and the builders of heavy guns the 110-ton gun seems to mark the limit of present materials and methods, and, in fact, to overstep that limit. These monster guns on the English war-ships *Benbow*, *Sans Pareil* and *Victoria* have all practically failed in some essential point of endurance; and while the lifetime of these costly war toys was officially fixed at only 75 or 80 full-service powder charges of 960 lbs., recent developments point to a very much shorter period of useful existence. In fact, so far, the first few service charges have caused cracking of the lining tubes, shifting of the outer coils or a drooping at the muzzle, any one of which defects renders the gun unreliable and more dangerous to the gunners than to their foes. The experts fail to agree as to the causes of this trouble, and while some ascribe them to a lack of longitudinal strength in a gun more than 48 feet long, others, again, lay the blame to improper rifling or to the form of the projectile used.

The fact of the matter is that ordnance officers have as yet but little reliable data as to the true effect of enormous charges and high velocities used in connection with modern rifled built-up guns, and the present massive projectiles. To test these guns to the point of destruction is costly amusement, for more than one gun would have to be destroyed before the true defects could be detected and remedied, and the results would be doubtful even after a dozen experiments. To deliver a mass of metal weighing 1,800 lbs. or more, with a muzzle velocity exceeding 2,100 ft. per second, out of a rifled bore 16.25 ins. in diameter and over 40 ft. long, can not help enormously straining the metal of the gun, and testing, perhaps to their destruction, the many coil joints, the lining, the rifling, and the construction and endurance of the projectile used. The point to be decided is which one of a number of tested points is the weak one, and herein comes the difficulty. While the 67-ton gun is not without its record of failures, it is a less costly and a more reliable gun than its 110-lb. brother, and there is a strong movement abroad to substitute it for the larger gun. This seems to us a sensible conclusion. A gun that can be trusted to hurl a 1,250-lb. shot with about the same velocity as the other, is a most efficient weapon, and is certainly infinitely more useful in battle than a larger gun that has as yet only a theoretical value, and may suddenly be found as valueless as a wooden log for purposes of attack, in an emergency. Reliable guns are what the commander of a warship wants, and a gun that will perforate 20 ins. of wrought iron seems good enough for all useful purposes.

The French also intimate very plainly that their 16.5-in. bore gun is a failure, and seem to have settled down to the 12.6-in., 65-ton, Canet gun as the maximum in size that can be relied upon. The largest gun in the German navy is the 12.01-in. Krupp, and they have stopped there, and Italy has mounted on shore her two 119-ton guns, lately built for the navy; and one of her eight 100-ton muzzle-loading guns, mounted on the *Duilio* and *Dandolo*, has already burst. Italy still has twenty 105-ton Krupp breech-loaders, distributed over five other ironclads, that seem, so far, to have given satisfaction, but the government is not adding to their number. It seems then that it can be safely stated that the day of monster guns on shipboard has passed, and it is now a question of better powder and more perfect projectiles.

The Growth of American Water-Works.

In our last issue the present status of water-works in the United States and Canada was discussed at length. Continuing our review of the information which has been collected for the next issue of our yearly MANUAL OF AMERICAN WATER-WORKS, we will summarize the facts in regard to growth of water-works.

At the close of the last century there were in the United States but 16 cities or towns having water-works, while in Canada there were none, the first works in Canada having been built at Montreal in 1801 by a company. The Montreal works were bought by the city in 1845. The 16 works built in the United States prior to the close of 1801, together with the date built, builders and present owners—

that is, whether company, individual or city—are as follows :

	Date.	Original ownership.	Present ownership.
Boston, Mass	1652	Co.	City.
Bethlehem, Pa	1761	Co.	City.
Providence, R. I	1772	Co.	City.
Morristown, N. J	1779	Co.	Co.
Geneva, N. Y	1787	Co.	Co.
Peabody, Mass	1790	Co.	City.
Plymouth, Mass	1796	Co.	City.
Worcester, Mass	1796	Indv.†	City.
Hartford, Conn	1797*	Co.	City.
Portsmouth, N. H	1798	Co.	Co.
Salem, Mass	1799	Co.	City.
New York, N. Y	1799¶	Co.	City.
Lynchburg, Va	1799	Co.	City.
Newark, N. J	1800	Co.	City.
Albany, N. Y	Prior to 1800	Co.	City.
Winchester, Va	Prior to 1800	City.	City.

* Probable date.
† Individual.
¶ Works started by city in 1774, but stopped by Revolutionary War.

some of the pitch pine distributing logs were renewed, and in 1786 some were replaced with lead pipe. The works in this city were built in 1799 by the Manhattan Co., which was organized to do a banking business and supply water. The city subscribed for 2,000 shares of the company's stock. The charter of the company provided that it must keep a tank filled with water in order to hold its charter, and although the company long since stopped supplying water it still keeps a tank filled, on or near Centre St., the same company now conducting the Manhattan Bank.

Starting with 16 works at the close of 1800 there were in the United States 50 years later but 67 in addition, or 83 in all, while Canada then had but four works. The growth of water-works has, therefore, been almost wholly in the last 40 years, by Table 3–S, the first, or upper part of which gives the number of works built in each state, the United States and Canada for each half decade from 1801 to 1870, and for each year and half decade from 1871 to date. The lower part of the table shows the number of works at the end of each decade.

This table, which it is proposed to supplement in a succeeding issue by a diagram showing the growth of all works and of public and private works, respectively, needs little comment. It will be seen that at the close of 1800 there were works in only the New England, Middle and South Atlantic groups of states, 16 in all, being those already named above. Prior to 1820 these three groups were the only ones having works, while not until the decade 1866–70 does the Northwest appear in the table, and then with but three works

TABLE 3–S.

UNITED STATES AND CANADIAN WATER-WORKS—SUMMARY OF DATES OF CONSTRUCTION BY GROUPS OF STATES FOR EACH HALF DECADE UNTIL 1870, AND FOR EACH YEAR FROM 1871 TO AND INCLUDING THE PARTIAL YEAR 1891.

	N. E.	Mid.	S. Atl.	S. C.	N. C.	N. W.	S. W.	Pac.	Total U. S.	Can.	U.S.& Can. Tot'l
Before 1801	8	6	2	..	..	..	..	..	16	..	16
1801-5	3	4	..	..	..	..	..	..	7	1	8
1806-10	..	3	..	..	..	..	..	..	3	..	3
1811-15	..	..	..	..	..	..	..	..	..	..	..
1816-20	1	2	..	..	1	..	..	..	4	..	4
1821-5	..	1	..	1	..	..	..	..	2	..	2
1826-30	1	5	3	..	1	..	..	1	12	..	12
1831-5	1	3	2	3	1	..	..	..	10	..	10
1836-40	1	4	1	2	2	..	..	..	10	1	11
1841-5	1	2	..	1	2	..	..	..	6	1	7
1846-50	3	9	..	..	1	..	..	..	13	1	14
1851-5	2	14	1	..	2	..	..	4	23	2	25
1856-60	6	13	2	1	3	..	..	5	30	2	32
1861-5	5	9	..	1	1	..	..	10	26	..	26
1866-70	20	30	1	3	16	3	..	8	81	..	81
1871	2	14	1	..	6	2	1	5	31	..	31
1872	6	12	1	2	8	..	1	3	33	1	34
1873	15	8	..	2	8	..	2	4	39	3	42
1874	8	11	1	..	9	2	..	5	36	2	38
1875	6	14	2	..	9	1	3	5	40	4	44
Total, '71-5	37	59	5	4	40	5	7	22	179	10	189
1876	9	11	1	1	9	6	1	7	45	3	48
1877	1	5	1	..	5	2	..	3	17	1	18
1878	7	11	3	2	5	4	3	4	38	2	40
1879	10	9	..	1	10	1	6	1	39	2	41
1880	8	10	1	..	5	3	5	4	37	4	41
Total, '76-80	35	46	6	5	34	16	15	19	176	12	188
1881	5	12	..	1	6	5	4	3	36	2	38
1882	10	17	4	1	21	13	9	7	82	4	86
1883	8	18	4	2	17	18	14	4	85	5	90
1884	21	21	2	..	17	20	17	7	105	4	109
1885	17	28	5	2	25	15	12	3	107	1	108
Total, '81-5	61	96	15	6	86	71	56	24	415	16	431
1886	15	31	7	4	35	24	10	7	133	5	138
1887	29	36	7	4	34	38	19	14	181	6	187
1888	13	33	11	8	47	47	18	21	198	9	207
1889	23	40	16	12	37	41	17	14	200	7	207
1890	14	25	12	1	33	32	11	25	153	6	159
Total, '86-90	94	165	53	29	186	182	75	81	865	33	898
*Unknown	..	4	..	1	..	.	3	6	14	2	16
'91	11	23	15	13	25	24	17	17	145	14	159
Total	290	498	106	70	401	301	174	197	2,037	95	2,132

NUMBER OF WORKS AT THE END OF EACH HALF DECADE.

1800	8	6	2	..	..	..	..	..	16	..	16
1805	11	10	2	..	..	..	..	..	23	1	24
1810	14	13	2	..	..	..	..	..	26	1	27
1815	11	13	2	..	..	..	..	..	26	1	27
1820	12	15	2	..	1	..	..	..	30	1	31
1825	12	16	2	1	1	..	..	..	32	1	33
1830	13	21	5	1	2	..	1	1	44	1	45
1835	14	24	7	4	3	..	1	1	54	1	55
1840	15	28	8	6	5	..	1	1	64	2	66
1845	16	30	8	7	7	..	1	1	70	3	73
1850	19	39	8	7	8	..	1	1	83	4	87
1855	21	53	9	7	10	..	1	5	106	6	112
1860	27	66	11	8	13	..	1	10	136	8	144
1865	32	75	11	9	14	..	1	20	162	8	170
1870	32	165	12	12	30	3	1	28	243	8	251
1875	80	164	15	16	70	8	8	50	422	18	440
1880	124	210	23	21	104	24	23	69	598	30	628
1885	185	306	38	27	190	95	79	93	1,013	46	1,059
1890	279	471	91	56	376	277	154	174	1,878	79	1,957
Unknown	..	(4)	..	(1)	..	..	(3)	(6)	(14)	(2)	(16)
'1891	290	475	106	70	401	301	174	197	2,037	95	2,132

* Completed or under construction prior to July 1.

TABLE 4–S.

UNITED STATES AND CANADIAN WATER-WORKS.—GROWTH OF WORKS FROM 1880 TO 1890 IN POPULATION SUPPLIED AND IN NUMBERS, BY STATES AND GROUPS OF STATES.

	Population supplied. 1880.	1890.	Incr. In.	p.c	Increase in pop'n on works built. Before end of 1880.	In. p. c.	During 1881-90.	In. p. c.	No. of w'k's at close of 1880.	1890.	Increase.	Incr. p. c.
Me	128,369	290,143	121,784	95	16,826	13	104,958	82	9	35	26	289
N. H	99,320	167,652	68,332	69	26,797	27	41 535	42	11	33	22	200
Vt	45,755	88,240	42,485	93	7,703	17	34,782	76	13	26	13	100
Mass	1,129,554	1,881,367	751,753	67	352,269	12	399,484	35	58	126	68	117
R. I	156,680	249,656	92,976	59	58,386	37	34,591	22	6	13	7	117
Conn	291,785	492,115	200,330	68	109,435	37	90,895	31	27	46	19	70
N. E	1,851,453	3,129,113	1,277,960	69	571,415	31	706,245	38	124	279	155	12
N. Y	2,669,935	4,038,074	1,368,139	51	910,523	34	457,616	17	74	192	118	159
N. J	524,724	942,235	417,511	79	198,634	38	218,877	41	22	54	32	145
Pa	1,720,460	2,641,352	920,892	54	578,594	34	342,298	20	107	202	95	89
Del	46,178	73,602	27,424	59	19,263	42	8,161	17	2	6	4	200
Md	351,671	498,023	146,352	42	102,369	29	43,983	13	4	16	12	300
D. C	159,871	230,392	70,521	44	70,521	44	0	0	1	1	0	0
Mid	5,472,839	8,423,678	2,950,839	52	1,879,904	33	1,070,935	19	210	471	261	123
Va	166,247	278,763	112,516	68	44,800	27	67,716	41	11	35	24	218
W. Va	37,072	76,535	39,463	106	14,676	39	24,787	67	2	9	7	350
N. C	4,825	94,253	89,428	1,853	2,168	45	87,260	1,888	2	14	12	600
S. C	49,984	81,831	31,847	64	4,968	10	26,879	54	1	5	4	400
Ga	107,502	228,598	121,096	113	65,320	61	55,776	52	6	16	10	166
Fla	7,650	57,797	50,147	655	9,551	125	40,596	530	1	12	11	1,100
S. Atl	373,280	817,777	444,497	120	141,483	39	303,014	81	23	91	68	296
Ala	53,918	140,996	87,078	162	33,214	62	53,864	100	4	18	14	350
Miss	3,995	47,816	43,821	1,097	564	13	43,257	1,084	1	6	5	500
La	216,090	264,496	48,406	23	25,949	12	22,457	11	1	3	2	200
Tenn	98,150	229,508	131,349	134	86,377	88	44,972	46	6	12	6	100
Ky	214,225	315,695	101,470	47	65,128	30	36,342	17	9	17	8	89
So.C't.	586,387	998,511	412,124	70	211,272	36	200,892	34	21	56	35	167
O	742,789	1,381,079	638,290	86	289,495	39	348,795	47	31	77	36	113
Ind	263,357	523,200	259,843	99	100,909	38	158,844	61	20	47	27	135
Mich	289,122	878,247	589,125	204	185,797	65	402,328	139	23	108	85	369
Ill	692,750	1,694,673	1,001,923	145	658,289	95	343,634	50	26	97	81	312
Wis	138,908	532,704	393,796	283	100,315	72	293,483	211	4	47	43	1,075
No.C	2,126,926	5,009,903	2,882,977	136	1,335,893	63	1,547,084	73	104	376	272	262
Ia	156,099	409,453	253,354	163	72,766	47	180,588	116	16	64	48	300
Minn	167,673	443,086	335,463	312	219,739	204	115,724	108	4	30	26	650
Kans	18,440	315,189	296,749	1,609	33,906	184	262,753	1,425	2	78	76	3,800
Neb		344,735	344,735	†			344,735	†	0	58	58	†
S. Dak	3,777	40,347	36,570	968	*1,411	*37	37,981	1,005	1	21	20	2,000
N. Dak		18,990	18,990	†			18,990	†	0	7	7	†
Wyo	2,696	29,671	26,975	1,001	3,692	137	23,283	864	1	9	8	800
Mont		41,954	41,954	†			41,954	†	0	10	10	†
N. W	288,635	1,643,425	1,354,790	470	328,782	114	1,026,008	356	24	277	253	1,054
Mo	463,407	817,317	350,910	75	207,271	44	143,639	31	6	31	25	417
Ark	13,138	70,383	57,245	436	12,736	97	44,509	339	1	11	10	1,000
Tex	65,729	351,784	286,055	435	66,989	102	219,066	333	5	52	47	940
Colo	74,620	218,023	143,403	192	78,909	106	64 494	86	11	51	40	364
N. M		19,783	19,783	†			19,783	†	0	9	9	†
S. W	619,894	1,477,290	857,396	139	365,905	59	491,491	80	23	154	131	567
Wash	6,512	142,402	135,890	2,087	6,440	99	129,450	1,988	3	29	26	867
Ore	22,347	70,775	48,428	218	24,038	107	21,390	109	4	22	18	450
Cal	410,658	642,535	231,877	56	189,711	46	42,166	10	51	94	43	84
Ariz		11,936	11,936	†			11,936	†	0	4	4	†
Nev	24,594	18,160	*6,434	*27	*7,584	*31	1,150	4	8	9	1	13
Utah	25,706	71,922	46,216	179	26,352	103	19,864	76	3	7	4	133
Idaho		13,181	13,181	†			13,181	†	0	9	9	†
Pac	489,817	970,911	481,094	98	239,157	49	241,937	49	69	174	105	153
Total U.S.	11,809,231	22,470,608	10,661,377	90	5,073,771	43	5,587,606	47	598	1,878	1,280	211
N. B	48,360	68,997	18,637	38	4,019	8	14,618	30	2	5	3	150
N. S	39,561	61,443	21,882	55	4,097	10	17,785	45	2	8	6	300
P. E. I		11,374	11,374	†			11,374	†	0	1	1	†
P. Q	256,441	383,544	127,103	50	68,892	27	58,211	23	12	21	9	75
Ont	286,997	438,187	201,190	85	92,898	39	108,292	46	14	38	24	192
Man		25,642	25,642	†			25,642	†	0	1	1	†
N. W. T		3,876	3,876	†			3,876	†	1	1	1	†
B. C	5,925	33,121	29,196	493	10,916	184	18,280	300	1	4	3	300
Total Can.	587,284	1,026,184	438,900	75	180,822	31	258,078	44	30	79	49	163
Total U. S. & C.	12,396,515	23,496,792	11,100,277	90	5,254,593	43	5,845,684	47	628	1,957	1,329	212

*Decrease. † Infinity.

As will be seen from the foregoing Boston was the first city supplied, by over 100 years, and Bethlehem, Pa., next. The Boston supply was from springs, by gravity to a box, or tank, while the Bethlehem supply was pumped from a creek to a tank. The Boston works were designed for domestic use, and fire protection, but it cannot be stated at this time whether water was distributed to consumers, or was conveyed from the tank in buckets or barrels. At Bethlehem water was distributed at least as early as 1769, as at that date and largely in the last 10 or 10½ years, there having been but 598 works in this country at the close of 1880, while at the close of 1890 there were 1,878, and on July 1, 1891, 2,037 works had been completed or put under construction, including 14 of unknown date.

The details of this wonderful growth are shown at the close of 1870. In the Southwest one town, St. Louis, Mo., was supplied between 1826 and

1830, but not another until after 1870. Since the latter date both of these groups have built works at a rapid rate, as will be seen from the following comparison, to which has been added corresponding figures for the United States:

	Northwest.			Southwest.*			United St's.*		
	No. works.	Increase.	Increase p. c.	No. works.	Increase.	Increase p. c.	No. works.	Increase.	Increase p. c.
Close of '70s...	3	....	....	1	....	....	243	....	....
" '75....	8	5	60	8	7	875	422	179	74
" '80....	24	16	200	23	15	188	598	176	42
" '85....	95	71	338	79	56	244	1,013	415	69
" '90....	277	182	192	154	75	95	1,878	865	85
July 1, '91†...	301	24	48	171	17	11	2,021	143	7

* Three of unknown date not included in Southwest and 16 not included in United States.
† Completed or under construction.

Looking at the column, just above, giving the total number of works for the United States, we see that 415 works were added during the five years 1881-5, and 865 during the five years 1886-90. This increase was continual year by year, until 1890 (see table 3-S), when there was a falling off of nearly 25 per cent., from 200 to 153, in the total for the year. For the period covered in 1891 143 works have been completed or put under construction, so that the total for the present year will be above that for 1890, but probably considerably below that for 1889.

It is significant that in the decade 1811 to 1815, which includes the war of 1812, not a works was built in either the United States or Canada. Again, in 1861–5, the civil war period, but 26 works were built, against 26 in the preceding and 81 in the succeeding half decade. In 1863 not a single system was built. Although the five years 1866–70 saw 81 works built the boom of the reconstruction period soon died out, and from 1871 to 1881, inclusive, 11 years, an average of only 36 works per year was built, the number reaching 45 in 1876, but sinking to 17 in the following year. As has already been stated, construction has increased since the close of 1881, with the exception of the present year and last year, when another period of depression has retarded water-works development. Of course the towns still unsupplied are limited, if not so much in numbers most certainly in size, as we shall endeavor to show later.

While the increase in number of works built in the decade 1881–90 shows the great activity in water-works construction during that period and indicates the number of municipal units that have been supplied since the close of 1881 these figures are not as significant as those given in Table 4–S. This table shows the population in cities and towns having works at the close of 1880 and of 1800, respectively, the actual and per cent of increase during the period, and in addition indicates what part of this increase is attributable to the growth of the works supplied before the close of 1890 and what part to the population on works added from 1881 to 1890 inclusive, the percentage being given here, also, in each case. For convenience the number of works at the two dates, the increase and increase per cent. are given in the last columns of the table. All the particulars are shown by states and groups of states and for the whole country.

As will be seen by referring to Table 4–S the total population on works in the United States at the close of 1880 was 11,809,231. At the close of 1890 the population on works had increased to 22,470,608, a gain of 10,661,377, or 90 per cent. Of this gain 5,073,771, or 48 per cent. of the total gain, was due to the natural increase of the population in the towns supplied at the close of 1880, and 5,587,606, or 47 per cent. of the total increase, was due to the building of works in towns not previously supplied. Considering these figures in connection with the increase in number of works, we see that while the latter increased from 598 to 1.878, a gain of 1,280, or 211 per cent., the population added by this large increase in numbers was but 47 per cent. of that previously supplied, the increase in numbers and in population added thus being to each other as 4½ to 1. Of course this is accounted for by the fact that all of the large cities were supplied prior to 1880.

By groups the greatest increase in population supplied is in the Middle group, where 2,950,839 was added. By percentages the greatest increase is in the Northwestern group, 470 per cent., the population supplied increasing from 288,635 at the close of 1880 to 1,643,425 at the close of 1890, a gain of 1,354,790. This group also has the greatest percentage of increase of population due to growth of towns supplied prior to the close of 1880 and works built since that time, the increase of 470 being divided into 114 per cent. due to the former and 356 to the latter cause. By states and provinces the increase cannot well be compared, as five states and three provinces had no works in 1880, and several others had but one, so that in some cases the increase is designated by infinity and in others by thousands, as South Dakota, which had but one works in 1880 and 21 in 1890, an increase of 20 works or 2,000 per cent.

For further details of growth in the past decade, either in numbers of works or population supplied, reference may be made to the table, where the figures are given for each state, and for the larger divisions and the whole country.

The practical value of this table, or at least a part of it, will be evident to all engineers engaged in providing for the future water supply of cities, as the figures given show for each state the percentage of increase in the total population of all towns and cities having works. Of course these figures have only a general bearing upon any particular city, but as they are the averages for places big and small, under varying conditions, they may serve as a rather broad basis of comparison in connection with the known growth and conditions of the particular locality in question.

The total increase in population supplied shows with what rapidity the demand for water-works material has increased in the 10 years under consideration. While the like population will, in all probability, not be added in the next ten years, it should be remembered that in most, if not all of the cities and towns included, not all the population is yet supplied with water, while in many the population taking water is less than half of the total. In addition, many systems are entirely inadequate to supply the population already dependent upon them, while for a vast number of works there must be provided not only more water and increased facilities for handling, storing and distributing it, but also a better source of supply, which in many instances will involve a large outlay of money for material and labor, and require marked engineering skill.

Unfortunately the figures showing the cost of the works at the close of 1880 and other figures indicating their extent are not at hand for comparison with the same figures for 1890. It may, however, be of some interest to know that in the past three years the cost of all the works in the United States has increased from about $430,000,000 to some $545,000,000, or 26 per cent. In the same period the mileage increased from about 24,000 to some 32,500 miles, or 35 per cent. These figures are only approximate, as the figures for three years back, taken from the first issue of the MANUAL, contained many estimates, while the present cost contains estimates for some 200, or about one-tenth of all the works, these generally being in the smaller places.

THE WATER-PIPES of DUBLIN are obstructed by an incrustation of oxide of iron to such an extent as to reduce the discharging capacity of the pipes one inch, on an average, according to the *Architect*.

CORRESPONDENCE.

Some Criticisms of the Forth Bridge.

CORVALLIS, Ore., Nov. 10, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I presume that the proceedings of societies, when published in your journal, become public property, and subject to public criticism through the same medium. Your issue of Oct. 17 contains a scathing criticism of the Forth Bridge and its designers, by the celebrated bridge engineer, Mr. THEODORE COOPER. It was made before a meeting of the Engineers' Society of Western Pennsylvania.

Mr. COOPER'S words are so sweeping and direct as to remove all doubt of their sincerity, and thousands of your readers must have felt something of that dumbfounded astonishment with which they filled the writer.

In effect, he designates the Forth Bridge as costly, clumsy and without design, and its eminent authors as amateurish and unskilled!

Mr. COOPER tells us that "an American would have taken that bridge"—I suppose we may make it personal, and believe him equal to the task—"with the amount of money that was appropriated, and would have turned back 50% to the owners, instead of collecting nearly 40% in excess of the estimate." Good! The Forth Bridge cost $2,400 per ft.; less 40% gives original estimate, $1,440 per ft.; less 50%, "turned back to the owners," gives us $720 per ft. as the price for which Mr. COOPER could have built a Forth Bridge. Excellent! Now let us compare this with the cost of some notable American bridges, as built.

The Brooklyn Bridge cost $1,610 per ft., or 2¼ times that sum. The St. Louis Bridge cost $3,500 per ft., or 4 times that sum. The North River Bridge is to cost $3,880 per ft., or 5 times that sum. Now I suppose Mr. COOPER, by common consent, has always taken equal rank with the eminent designers of those bridges; but it is evidently reserved for himself to establish his unquestionable superiority to such men as ROEBLING, EADS and LINDENTHAL, not to mention their compeers across the water.

Not only does Mr. COOPER claim that the Forth Bridge was extravagant in cost—with how much truth, let the above facts show—but, says he, "it is ill designed—it is no design at all." "There was a skeleton made on paper;" "it was called a design"; "it was not." Surely this is merely playing with words. To design (*de signum*) is to explain by a sign or mark, just as to describe (*de scribo*) originally meant to explain by writing.

A rough outline sketch is a design of general proportions. A shop drawing is a design of detail proportions and parts. It *was* a design.

I have before me Mr. BAKER'S addresses, delivered from time to time during the erection of this bridge; and I will undertake to show that, as an object-lesson in true design, and adaptation of means to ends, this "clumsiest" and "most awkward" work stands to-day unsurpassed.

Given the problem: To construct a bridge of unprecedented span, across one of the stormiest estuaries in the world, that should withstand with safety a wind pressure of 56 lbs. per sq. ft. throughout its whole length. It was realized that the chief sources of stress were the dead and wind loads; and it was decided that the surest way to diminish the sum total of these was to concentrate the weight and area in few members of large size, and to reduce the secondary bracing to a minimum. The next question to determine was: what cross-section for these few large members would, weight for weight, give the greatest resistance to stress, and present the least resistance to the wind. On this point I will quote Mr. BAKER:

"After carrying out not a few experiments myself, and passing in review the numerous experiments made by others during the past 30 years, I was satisfied that a circular form of cross-section was the best for the Forth Bridge." Having now determined on the depth of truss, length of panel, and section of members in their natural logical order, the next step was to decide on the method of connections; and here, with that fine adaptability which marks the true designer, it was decided to pass, at the connection from the circular to the square section, as being better adaped to engage the flat and rectangular forms of the ties and top chord.

All design, as I understand it, is a matter of compromise, whether the subject be a modern battle-ship, or a Forth Bridge; and every born designer, such as Mr. BAKER, will accomodate first the *primary* functions of a structure, and will subordinate all secondary considerations to that.

But this is *not* design, says Mr. COOPER. Then what is? I will paraphrase Mr. COOPER: If you would design a good bridge, you must begin with the connections. Having determined on them, make the section of your main members such as will suit these connections. Having now a cheap connection and a section to match it—pins, eyebars and square sections presumably—do the best you can to reconcile these to the requirements of the bridge in question!

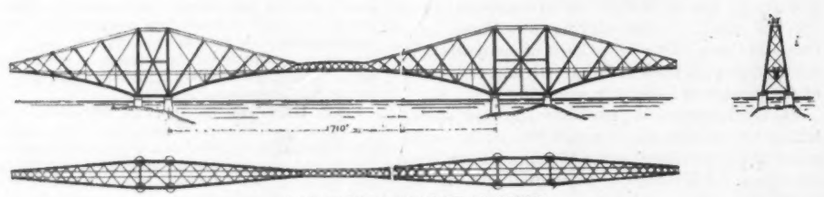
This is design according to Mr. COOPER. It is not true design. It is "insular conservatism" of the rankest type,

It is design crippled by a keen competitive market. It is no more true design than for an architect to fix the area and height above ground of his chimneys and then to build a house beneath to match it.

The outline and proportions of the bridge being settled, it was next, according to Mr. COOPER'S paraphrase, "handed over to the mathematicians." Here Mr. COOPER is in error again. He insinuates that Mr. BAKER should have worked out the whole bridge himself, strains, details and all; and purposely, or by accident, he conveys the impression that there was no one man on that bridge who combined the technical and practical fitness for the task in himself. If this is Mr. COOPER'S idea, he is grossly in error. The men responsible for this bridge belong to a school of engineering which holds that a man has no place at the designer's desk unless he has first mastered the workman's craft. I will venture the statement that Mr. BAKER, or any of his staff, could have gone to any corner of the vast workshops, or any point of the bridge itself, and taken his place as a practical mechanic. Could Mr. COOPER have done the same?

But if the Forth Bridge is such a monstrosity, if the engineering world has been giving almost unanimous praise to a structure which it has been reserved for Mr. COOPER to pronounce "the clumsiest engineering work on record," is it asking too much to request that he should supplement his criticisms with a suggestion as to how the work might have been done better. As a young engineer, seeking knowledge and reading with avidity anything that such men as Messrs. COOPER and BAKER may say or write, I would respectfully ask for a general indication as to how the Forth Bridge problem would have been solved by this suppositious American, who, in the financial respect, as I have shown, was to put, not merely Mr. BAKER, but his own countrymen, to the blush.

AN AMERICAN DESIGN FOR THE FORTH BRIDGE (1882).



THE FORTH BRIDGE AS BUILT

I am the more encouraged to ask for this favor, since such a step on Mr. COOPER'S part would not be without precedent. Among the writer's "bridge" clippings is one from the *Railroad Gazette* of Feb 3, 1882, in which Mr. LINDENTHAL—with his usual grace and a courtesy of expression due to the dignity of the project and its eminent authors, which Mr. COOPER would do well to study—criticises the then contemplated Forth Bridge.

He shows how it would be treated "from the American standpoint." I have traced the American and English designs side by side, and, by the courtesy of your journal, beg to present the comparison to your readers as an interesting study of the economics and æsthetics of bridge design. At first glance they will be struck with the fact that Mr. LINDENTHAL must have had a profound respect for the magnitude of Scotch rolling stock when he ran counters in the cantilevers right up to the piers themselves—on what theory indeed are they there at all?—and that he must have had even greater respect for Scotch granite, when he left it to the mere stability of the Inchgarvie piers to take the horizontal thrust of the cantilever chords.

[It is due to Mr. LINDENTHAL to say that the omission of the longitudinal compression member between the Inchgarvie piers was a draftsman's error, and that Mr. LINDENTHAL wrote to the *Railroad Gazette* immediately after the publication of the above drawing to correct the mistake.—ED. ENG. NEWS.]

The contrasted designs admirably illustrate the results that follow in working on Mr. COOPER'S plan of allowing the details to govern the general design. Pin connections, short lengths, and rapid erection produce a forest, a veritable network of material, upon which the effects of a Firth of Forth nor'easter would be something interesting to calculate. Look at the mass of lateral bracing, multiply it by six—for there are to be "six planes" of it—add the area of the vertical trussing; imagine a 60-mile gale striking this agglomerate with a somewhat upward trend, so as to take a hold on every plate and angle iron in the "six planes" of this $720 per ft. masterpiece, and predict the result!

This, however, according to Mr. COOPER, is design. *Ipse dixit.* The design of Mr. BAKER, on the contrary, is striking in its fitness, by virtue of its concentration of material, and the free and open disposition of its parts, to meet the conditions above mentioned; and, by the sheer force of contrast, it clearly illustrates the true method in design, which is to allow the primary functions of a structure to govern the disposition and detail of its parts.

Mr. BAKER set out, he tells us, to build "a bridge which, when completed, may, by its freedom from vibrations, gain the confidence of the public and enjoy the reputation of being not only the biggest and strongest but also the stiffest bridge in the world." The writer has stood in the portals of one of the main cantilevers, *before the center truss was in*, at a time when the whole 700 ft. of it was subject to the stress of a stiff easterly gale. At this point, 150 ft. in mid-air and 700 ft. from the piers, there was neither sway nor tremor susceptible to the senses. To him at least it is certain that this result was obtained, not, as Mr. COOPER would insinuate, by a happy chance, a clumsy but fortuitous arrangement of material, but rather by the true and logical process of experiment, invention and design. Yours truly,

J. BERNARD WALKER.

[We have given Messrs. COOPER and LINDENTHAL an opportunity to present their side of the case, and append their replies as follows.—ED. ENG. NEWS.]

NEW YORK, Nov. 20, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The above article is based upon some impromptu remarks upon a paper on "Bridge Design" before the Engineers' Society of Western Pennsylvania, as taken down by the reporter of the meeting. These remarks were never submitted to me for revision, and the whole matter had passed from my mind until I saw them published in your paper of Oct. 17.

This report is, however, a fairly good one; but if I said that 50% of the money could have been turned back to the owners by an American engineer, I retract it and make confession of my error.

What I intended to say, and what I think I did say, was that American methods of design, construction and erection would have saved, in my opinion, 50% of the cost of workmanship.

Allow me to assure Mr. WALKER that the picture he has drawn as representing my idea of a design is not recognizable by me.

Short lengths and a forest or network of material in six planes is hardly my idea of a typical American bridge design.

THEODORE COOPER.

PITTSBURG, Pa., Nov. 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS.

SIR: Thanking you for inviting my reply to Mr. J. BERNARD WALKER'S communication on the Forth bridge, I wish to say merely the following:

My contribution to the *Railroad Gazette* of Feb. 3, 1882, had reference to the original design of Messrs. FOWLER and BAKER for the Forth bridge and not to their later, final design.

The forest or network of material in my sketch, so objectionable in Mr. WALKER'S judgment, is only apparently greater than it is in the Forth bridge as actually built. The above elevations on a small scale are very deceptive. The existing mass of cross bracing in the Forth bridge is no less, if not more dense than in my sketch on a very small scale, in which cross rods 2 ins. in diameter appear of the same dimensions as the main tension members, 10 ft. square, in FOWLER and BAKER'S design. As a matter of fact, my design, with the towers 150 apart, would have required less lateral bracing than the actual bridge, in which the towers are 125 ft. apart. Any one who has been on the Forth bridge since completion can testify to the great, but nevertheless necessary, density of the bracing between the trusses, which cannot be adequately shown in the above sketches. The aggregate surface of the structure exposed to wind pressure from any direction would have been no more, if not less according to my sketch, than what it is in the bridge as built. The difference is only between that of a large number of small surfaces and that of a small number of large surfaces.

The counter-rods, shown in my sketch as published at the time and mentioned by Mr. WALKER as superfluous, would appear to be so, but were intended both for symmetry of appearance and for subdividing the panels of the cantilevers by suspending from the intersections of the diagonals intermediate floorbeams and thus making the floorbeam stringers of nearly the same length, 30 ft. throughout, and of same section and depth as in the 500-ft. suspended trusses, although not shown in the sketch, which was incomplete also in other respects. (The tracing was hurriedly mailed at that time before I had seen it.)

In 1882 the capacity of the rolling mills was not what it is now. I well remember the trouble I had in getting groove-rolled steel plates 20 ins. × ⅛ in. and 30 ft. long, or steel eyebars of about 14 sq. in. section, both of which were then the heaviest anybody could make. Beams and channels of steel could be obtained only for light sections. Since then very great progress has been made in the capacity of rolling mills. Capital is dear in this country. The engineer in his designs is obliged to economize, and to accommodate himself to the capacity of the rolling mills and bridge works. The advance in practice which he may prescribe or induce can only be gradual, if excessive cost is to be avoided. My sketch and criticism was therefore predicated on what could be considered fairly practicable with an ordinary advance in the capacity of the steel and bridge works in 1882. Having pointed out this much, I hope that it will not be assumed that with the resources of the present day I would make the same suggestions as to design now that I made in 1882.

Much that I had said in that communication on the original design for the Forth bridge would not have applied to the later, final design, as executed. A comparison of the two will show that some very essential modifications had been made in the final plans, meeting some of the objections then made. But I am glad to acknowledge that my apprehensions then expressed as to the excessive costliness of the proposed construction proved to be somewhat exaggerated, although the work did cost much more than the original estimates, published at the time.

Nevertheless it remains true now, as it was then, that a similar method of construction would not be thought of in this country. What would do quite well in Scotland, would not do in the United States.

The Forth bridge, as built, required much of the kind of skilled labor employed in shipyards. Such labor is much more expensive in this country than it is in Scotland.

The conditions and requirements for bridge building in the United States are different also in other respects from those in England, and they have evolved a different and more economical practice. Here, the bridge members are manufactured at bridge works specially equipped for it, then transported, often hundreds of miles, and assembled only during erection. There were not and are not now such bridge works in England. The decision of the Forth bridge engineers to manufacture the bridge members at the bridge site was therefore quite natural. It was the best, under the circumstances, and I should not now be inclined to question the wisdom of their decision merely because we follow and are obliged to follow a different practice in this country.

The massing of the strains into heavy, bulky members is one of the chief and original merits in the Forth bridge design, as I had pointed out at the time. It was never attempted on such a grand and bold scale before. It increased the difficulties and cost of construction greatly. The difficulties, too, were novel, but they were successfully solved, easier and cheaper, however, in Scotland with its cheap skilled labor than they could have been in this country.

There probably always will be divided opinions as to the merit of pin connections vs. riveted connections. Since Prof. WINKLER and his confrères evolved the theory of secondary strains in bridges, and thus caused engineers to particularly question the strength of riveted connections, our knowledge of the physical properties of iron and steel has also increased, with the result of greatly allaying the suspicions entertained as to the safety of such connections, when so rationally designed as in the Forth bridge.

There are other features in this structure on which bridge engineers would probably show less difference of opinion, as, for instance, the seemingly unnecessary length of the shore cantilevers, which appear to have been made, from reasons of symmetry, of equal length with the cantilevers of the main spans—a little expensive but architecturally more satisfactory.

Whatever differences of opinion may exist, engineers, who can appreciate the difficulties in the construction of such a vast and great work, will unite in gladly

acknowledging the great skill, courage and resourcefulness of the engineers who so successfully designed and built it. The Forth bridge is now a *fait accompli*. It is what its designers promised it would be, rigid, durable and strong.

The cost was greater than originally estimated, as will sometimes happen with unprecedented work; but the full value was put into the bridge, which is just so much better for the greater cost. GUSTAV LINDENTHAL.

N. Y. Dock Department Cement Tests.

NEW YORK, Nov. 23, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The specifications for these tests as issued May 9, 1891, are as follows: "The cement, when molded on glass, must be capable of being steamed for three hours and immersed in boiling water for 48 hours, without leaving the glass or showing cracks or contortions."

The purpose aimed at by this test seems specially to be to determine the existence of any free lime in the cement, which, when used as mortar in hydraulic concrete or any other work, might have a final detrimental effect on it. Several other well-known methods of determining free caustic lime (CaO) in hydraulic cement are already at our disposal, whereby the safety or unsafety of a cement can be pronounced without any difficulty, and without risking the condemnation of good, reliable cements. If sound theories, however, and intelligent comparative experiments (of which no mention is made) form the basis of this proposed "boiling water test," it will be received gratefully; but no mistake of any sort can be permitted on this line, for the risk is too great of compromising there by the interests of others. I therefore take the liberty to submit for discussion the following remarks and queries:

The first question of which we are reminded is this: Does this "boiling water test" give positive evidence of the presence of caustic lime (CaO) in hydraulic cement? In order to answer this inquiry it became necessary to make tests with Portland cements, and with the natural light burned cements, such as Rosendale and others. Fifteen tests of natural light burned cements were made; two of these stood the boiling in water for two hours, at the expiration of which time they left the glass; in all of the other 13 tests the cement cracked and crumbled during the boiling of the water. These 13 samples contained no caustic lime, which was proved by tests, and were slow setting cements, while the two samples first referred to as standing the boiling in water better than the other 13 were quick setting cements, and contained more lime soluble in water than the latter. Thus it seems that this test does not confirm the idea of its value as a test for determining the existence of caustic lime (CaO) in this class of hydraulic cements. All the samples of the natural cements tested by the boiling water process were of the natural cements known in the market as having given excellent results as hydraulic cements in every kind of construction.

Tests for caustic lime were made by the ordinary well known process on one dozen different brands of Portland cement. One only was found to contain caustic lime; the other 11 were considered free from caustic lime and were classified as safe and reliable Portland cements. All of the 12 samples were then submitted to the boiling water test. After a few hours of boiling all, excepting two, left the glass, and none cracked or crumbled during the operation. Yet, with the exception of the cement first referred to, which was by the ordinarily adopted tests found to contain caustic lime, I consider all the rest of these cements good, reliable Portland cements.

These experiments, therefore, thus far seem to prove that the water boiling test is not fair and reliable as to the finding of caustic lime in hydraulic cements, but is rather a deceptive one whereby good, reliable cements may be classified as unsuitable and dangerous. This is unfair and discouraging to honest manufacturers.

Let us examine whether this boiling water test is not apt to produce undesired and detrimental effects on first class hydraulic cements during the setting stage. It is a well known fact that hydraulic cement gaged by hot water will set quickly, giving a high tensile strength in a short time, but will finally return to a low and poor result. Pure aluminate of lime, heated at 200° Fahr. bursts and dissolves into powder while setting. At an ordinary temperature it sets extremely hard and is considered one of the principal elements in the setting and hardening of hydraulic cements with water. All good Portland cements contain free lime soluble in water and which is anhydrous (CaO); immediately after calcination. It absorbs water from the moist atmosphere, whereby the caustic lime is converted into hydrate of lime.

The setting and hardening of hydraulic cements with water seem to be the result of these different chemical actions, 1st, the hydration of the aluminate of lime, and 2d, the reaction of the free hydrated lime on silicates of lime simple or multiple, existing in all hydraulic cements and acting like puzzuolana. The calcination of lime with clay produces no good hydraulic cement, unless the proportion of clay to that of lime is such as to form:

1st. Aluminate of lime, represented by one of the following formulas: $Al^2 O^3 CaO$; $Al^2O^3 2CaO$; $Al^2 O^3 3CaO$. 2d. Silicate of lime, simple or multiple, having a puzzuolana quality. 3d. Free lime acting on the puzzuolanic silicates, and forming silicates approaching the following formula: $SiO^2 2CaO 3HO$; $SiO^2 3CaO 4HO$.

The above facts and theories appear to demonstrate that it is advisable before the adoption thereof that the boiling water test should be submitted to critical comparative experiments, and that not until good scientific and practical proofs have been established should its use as a test be authorized. E. J. DESMEDT, Chemist.

Selectmen as Engineers.

CLEVELAND, O., Nov. 19, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I enclose a newspaper clipping which may be of interest to your readers as illustrating the faith which some people seem to have in their selectmen as bridge engineers, or else of faith in the "greater durability" of iron simply because it is iron, without regard to the quality or quantity. I have seen this same article copied in at least one trade paper, not in a spirit of criticism, but of information.

The description of the bridge here given is too indefinite to criticise specifically, but as nearly as I can make out the trusses have no bottom chord, which is hardly considered good modern practice in bridge designing. Then, again, the floor system seems to be somewhat deficient in "strength as well as rigidity," newspaper articles to the contrary notwithstanding. With all due respect to town selectmen as selectmen, I would advise townspeople to instrust their bridge engineering to reputable bridge companies rather than to their town fathers.

GEO. E. GIFFORD,
Prin. Asst. Eng. King Bridge Co.

[The clipping enclosed is from the Hartford (Conn.) *Courant*, and sufficiently explains itself without further comment.—ED. ENG. NEWS.]

Crossing the Pequabuck River on South Main St. in Terryville, there has just been completed an iron bridge which is unique in design and worth the attention of town officials throughout the state, as it is the only one of the kind known to be in existence. With the exception of the plank flooring and a few comparatively small castings, the bridge is made entirely of old railroad iron. It is a truss bridge, having a span of 19 ft. The roadway is 30 ft. wide, and in addition it has a sidewalk 8 ft. broad, the whole surface being covered with concrete.

The bridge rests upon stone abutments, on each of which an iron rail rests and forms the "mud-sills." Upon these "strings," which are also old iron rails, are laid. Of these there are 15 in this bridge, as they are placed at equal distances of 2½ ft. apart. Another rod or "spindle" across the center, under and at right angles with stringers, is supported by iron rods depending from the trusses, which also support the bridge.

Each of the trusses is formed by two rails, the ends of which are fluted into solid iron castings made of especial shape to receive them, and meeting at the center of the bridge are also held together by similar castings, through which the iron rod extends, and braces extending on either side to the end of the spindle give strength as well as rigidity to the structure. Heavy plank covered with a concrete pavement forms a floor of the structure.

The idea of using old railroad iron for town bridges was conceived by JASON C. FENN, of the Board for Selectmen, who built the first one of this character three years ago and has designed and constructed several more since that time, in each of which he has made improvements. The one just finished, under his personal supervision, is the most perfect, and combines beauty, strength and cheapness. It is believed that these bridges can be built at no greater cost than substantial wooden bridges and their durability is of course much greater.

Notes and Queries.

W. C. P. inquires if there is a treatise on "Henck's method of closing traverses" and where he can obtain it.

We know of no such treatise, nor for that matter of any such special method. The process of closing traverses is well understood and hardly capable of advantageous modifications.

H. B. S. writes, seeking information as to what sections of the country steam users are most troubled with scale forming waters.

[In the entire Mississippi Valley there is more or less trouble of this kind, most conspicuously, of course, in limestone regions. There are also many districts of the Atlantic and Pacific slopes which are troubled with hard waters. We have published a good deal of more detailed information on this subject, and much may be found also in the proceedings of the American Railway Master Mechanics' Association.]

P. A. R. asks whether it is proper to set grade stakes on the inside of the curve, bringing that rail to grade and then elevating the outer one, or *vice versa*. He suggests that the former is the more rational practice, and it also happens to be the usual one, except for the practical reason that as it is desirable to have a full coat of ballast on curves it would be better to maintain the center line on a constant grade, raising the outer rail and lowering the inner one by an equal amount equal to half the desired elevation.

A SUBSCRIBER desires an exact and concise definition of the word "plant" as used in connection with engineering construction. The new Century Dictionary defines this word as follows: "The fixtures, machinery, tools, apparatus, appliances, etc., necessary to carry on any trade or mechanical business, or any mechanical operation or process." Th's, we think, best covers the true meaning of this word. As we understand this word "plant" it does not include anything that forms a permanent part of the work to be performed, nor does it include fuel, oil, tool steel, forage and material of like nature which is being steadily consumed in the carrying out of constructive work. Horses and mules, strictly speaking, may be considered as "plant," for they may be classed as working engines. But the corn and oats that they consume is not plant any more than is the fuel or oil used in running a steam engine. The distinction is plainly made in the following quotation given in the Century Dictionary: "The entire plant, and even the fuel, were transported on heavy wagons across the Karroo."

"X.," SIDNEY, O.—The standard book in English is Latham's "Sanitary Engineering," of which, however, it is now difficult to obtain copies, either in the original London edition or the American reprint published by ENGINEERING NEWS. This work contains a full account of the whole field of sewerage engineering, without, however, treating of sewage disposal. This branch of the subject is carefully considered in Baumeister's "Cleaning and Sewerage of Cities," which, as a comprehensive treatise on sewer construction and the disposal of street refuse, is now by all odds the best book in the market. Price, $2.50. There is an English book by Slater on "Sewage Treatment, Purification and Utilization" (price, $2.25), which is an excellent work. The book by JULIUS W. ADAMS, on "Sewers and Drains for Populous Districts" (price, $2.50), is excellent as far as it goes, but it does not treat of the separate system. This omission, however, will be supplied by Staley & Pierson's "Separate System of Sewerage," a second edition of which work is now under preparation. Colonel WARING'S "Sewerage and Land Drainage" (price, $6) contains a full description of the Waring sewerage system. It is an excellent and comprehensive work. There is a great scarcity of standard works on this subject, and if any engineer wishes to obtain the thanks and dollars of his colleagues, he has only to write a really good book on sewerage and sewage disposal.

Standard Drainage Plans, City of Mexico.

In the inset sheet which accompanies this issue we show a series of standard plans as adopted for the new main drainage works for the City of Mexico. These will be described more fully in our next issue in connection with some further drawings which accompany a paper by Mr. ROBERTO GAYOL, City Engineer, in charge of the works.

A Ten Months' Test of Compound Locomotives.

The East Tennessee, Virginia & Georgia Ry. has four compound locomotives in service, of the 2-cylinder type, built by the Schenectady Locomotive Works. In our issue of Nov. 22, 1890, we described tests of these engines, made by Mr. ANGUS SINCLAIR, which showed a coal economy of 28% over that obtained with ordinary locomotives built exactly the same in every other respect. The tests were made with one run of each engine hauling a train of coal cars from Knoxville to Coal Creek, 31 miles and return.

A more satisfactory demonstration of the advantages of the compound locomotive, however, is the result of extended tests in daily service. Ten months' experience on the East Tennessee, Virginia & Georgia Ry., during which careful records were kept, has shown a saving in fuel on the passenger locomotives of 25.56% and on the freight locomotives of 24.70% compared with ordinary locomotives of the same class. These results were reported in a paper by Mr. C. H. HUDSON, General Manager of the East Tennessee, Virginia & Georgia Ry., in a paper read Oct. 7, before the Western Society of Engineers. We reprint it, nearly in full, as follows:

In ordering a lot of locomotives the writer had one 10-wheeled passenger engine out of 3 built on the same specifications compounded, and two consolidation freight engines out of 18 on the same specifications, compounded.

The engines were all built by the Schenectady Locomotive Works and the compounding valves were of the Pitkin design. The weight of all these engines was the same, 126,000 lbs., without the tender; and they were delivered and put into service about the same time. The simple consolidation engines had 20 × 24 in. cylinders, while the compounds were 20½ ins. and 29 ins. × 24 ins. The cylinders of the 10-wheeled simple engines were 19 × 24 ins., while those of the compound were 19 ins. and 27 ins. × 24 ins.

The consolidations were substantially duplicates of a large number of other engines of the same character which after some years' use had been worked up to a very economical point. During the previous year we had procured a 10-wheeled passenger engine, which had been changed experimentally until it had become unusually

economical in fuel. This was the basis of the 3 new 10-wheeled engines, and they were found most excellent in their workings.

The 10-wheeled engines were put in service Sept. 1, 1890, and run upon the eastern end of the East Tennessee, Virginia & Georgia Ry., upon a run of 131 miles, and over grades nominally 60 ft. maximum and very long (some of them actually 77 ft.), with 45% of the line curved, from 3° to 8° curves, and not equated. Thus we had grades and curves combined equal to about 85-ft. tangent grades.

There were three regular trains *each way*. Two of them each way, or four trains, weighed an average of 440,000 lbs, occasionally running up to 530,000, and ran at a speed ranging from 32 to 38 miles per hour. The other two were usually of 155,000 lbs. weight, but occasionally ran up to 250,000, and ran at a speed of 27 miles per hour. All made part of the stops and some made all. The 10-wheeled passenger engines were put on these runs, following each other around, four being in the runs a part of the time and three a part of it. In this way they all got the heavy fast trains at times, and all got the light ones. This service has been kept up until the present time. The work done from Sept. 1, 1890, to June 30, 1891, a period of ten months, is taken as a test of the engines, and a measure of the value of the principle of compounding. The two consolidation compounds were placed on the same division, and for six months ran the road with many other engines, but especially with four new simple engines of the same age, build, specifications, &c., following each other around and changing men about the same time. They were then placed upon the western division of the road, where the grades are lower, being 60 ft. maximum, and somewhat less curvature, but not equated. As in the other case, four engines of the same age, build and size, specifications, etc., were compared with our compounds, running the road with them and changing engineers and firemen the same.

The comparisons of the 10 months' work of the passenger engines are shown in the following tables:

COMPARISON OF PASSENGER ENGINES.

	Miles run.	Car miles.	Av. cars per train.	Lbs. coal consu'd.	Lbs. coal per car mile.
Two simple engines	107,885	564,905	5.23	6,263,654	11.086
One compound engine	48,100	254,204	5.17	2,097,911	8.252

Saving 2.834 lbs. of coal per car mile, or 25.56%.

The work of four simple and two compound engines for 11 months is shown as follows:

	Miles run.	Car miles.	Av. cars per train.	Lbs. coal consumed.	Lbs. coal per car mile.
1 simple engines, East End, 6 mo	81,226	1,335,045	16.43	8,252,533	6.132
4 " " West " 5 "	61,318	1,190,786	19 41	5,977,917	5.029
Total 11	142.544	2,525,831	17.23	14,230,450	9.634
2 compound engines, East End, 6 mo	27,682	495.050	17.88	2,451,112	4.957
3 " " West " 5 "	31,550	712,291	22.57	2,667,505	6.746
Total 11	59,232	1,207,341	20.38	5,121,647	4.242
Average per engine per month for:					
Simple	3,240	57,405	17.23	323,419	5.634
Compound	2,692	51,879	20.38	232,802	4.242

Saving 1.392 lbs. of coal per car mile, or 24.70%.

Here we have a marked saving in a year's work. We believe the conditions were such that the test is of much more value than were the first ones made, as they show the everyday work of the compound engines compared with exactly the same simple engine under the usual working conditions. No tests can be fairer, and I have seen none of more value.

I regret to state it, yet it is true, that there was at the start a universal prejudice against the compound among the engineers and firemen. They were pronounced failures before they were set up; and long after they had shown their good qualities the unfavorable criticism continued. They "would not start the train," but they did it. They "could not run up the long hills," but somehow they did it quite as easily as the other engines. They "could not pull within two or three cars of the other engines," but a year's work shows that they averaged larger trains and in repeated cases they have pulled as heavy trains as any engines on the road. But when the men saw the compound passenger engine run the round trip with a tender of coal, and run easily a hundred miles with one tank of water, they had to admit that there was some good in the new departure.

It is our belief that this test of nearly a year in everyday work, with changing engineers and firemen, against exactly similar simple engines, doing the same work at the same time, is more valuable than any tests yet reported in this country, and demonstrates beyond question the value of the compound principle in locomotive engines, in the matter of coal consumption. The importance of this is seen when it is known that the cost of fuel is about 10% of the whole cost of operating, and when we consider that the 32,000 locomotives in this country probably consume 30,000,000 tons of coal per annum.

COST OF REPAIRS.

There is, however, another matter to be considered, and it is one that has rendered American engineers sceptical as to the real value of the compound engine. That is one of repairs, as well as first cost. It stands to reason that the cost of maintaining three cylinders or four cylinders will be larger than the cost of maintaining two. To what extent this excess will be found is not known.

During the first four months of our use of the compound engines we made quite a number of changes, hoping to improve them. This was not necessary to keep them running, and should not be construed as running repairs in any comparison with other engines.

The intercepting valves were changed in various ways and the cylinders bored out, upon the consolidations, from 20 ins. to 20⅝ ins., giving increased power. This work was all done by December, and in order to ascertain how the running repairs of the compounds compared with those of the simple engines, I have a report of the repairs upon the engines under consideration from Jan 1 to June 30, 1891, a period of 6 months, while they were running together, and for 6 months of the time in which the consumption of coal is considered. Considering first the freight service, we find that:

4 simple engines in 6 months ran.....76,827 miles
Total cost of running repairs done..... $1,312.66
Cost per mile run.....1.70c.

In the same time and over the same ground, the

2 compound engines ran.....39,268 miles
And the running repairs cost..... $612.72
Or per mile.....1.55c.

Showing that for this six months the compound ran more economically than the simple, as far as repairs are concerned.

It is quite probable, however, that in another six months this would be evened up, and the cost per mile would have been equal to that of the simple engines.

It should be borne in mind, however, that the compound engines did more work; that is, hauled more cars.

The simple locomotive hauled.....1,456,978 car miles
Or per train.....19 cars
While the compound locomotive hauled 835,830 car miles
Or per train.....21.3 cars

During the same six months the

2 simple passenger engines ran.....69,220 miles
Cost of repairs.....$1,213.12
Or per mile run.....1.75c.

While the compound passenger engine ran 26,894 miles.
Cost of running repairs.....$527.51
Or per mile run.....1.77c.

Substantially the same as the simple

The work done by the compound (average car per train) was slightly less than with the simple engines, but not enough to make any perceptible difference.

These figures of course do not include any general overhauling, as the engines were all new, but they do cover the everyday work needed to keep our engines up to the standard.

How much the general overhauling may be affected by the compounding cannot be determined by so short a trial. I see no reason, however, why it should add materially to it. It is true our pressure is a little higher, but we use less coal, and we have not been able to discover thus far any different effect upon the firebox than that with the simple engines.

When we consider that with cheap coal (say $1.50 per ton) the cost per engine-mile for fuel is for freight trains about 7 cts. per mile, and for passenger 4½ cts., we can see that a saving of even 20% in fuel means over a cent a mile, and that it cannot be outweighed by any reasonable, or I may say possible, increase of repairs, as but a small part of such repairs pertain to or are affected by the parts compounded.

We believe this to have been a good practical test of the two-cylinder type of compound engines; and while no claim is laid to perfection, it seems to have covered a sufficient length of time, amount of work and variety of climatic and other conditions to have overcome the influence of any prejudices, or efforts for or against any particular engine, or of any special skill on the part of any one man, that in a short run or experiment might have a marked effect.

It seems safe to conclude that the compound principle, as developed in these engines, is a valuable improvement upon the simple engines, and that its increased economy in fuel is of sufficient magnitude to more than overcome any possible increased repairs.

MACHINE GUNS, of the Griggs-Schroeder type, are to be made at the Cramp's shipyard in Philadelphia. Fifty of these guns, 6-pounders, are contracted for by the government, and the Colt Arms Co., of Bridgeport, Conn., has not been able to turn them out fast enough.

The Electric Lighting of Warships.*

BY LIEUT. HAMILTON HUTCHINS, U. S. N.

Marked progress has been made within the last few years in the development of electric appliances for naval use. It is now nearly ten years since the U. S. S. *Trenton* started on her cruise to China. She was the first man-of-war of any nation to be supplied with an electric light installation for internal lighting. Since that time the demand for electrical energy on board ship has gradually increased until now a modern battleship carries a generating plant of 120 EHP. for the distribution of light and power. In the building of our new navy, the requirements in construction and workmanship are fairly rigid in our electrical equipment, being based on the experience of our own officers in handling the apparatus as well as on the results of experiments abroad. So that our government may be said to be keeping pace with the times, and our ships generally are the equal of those of other nations in the matter of electrical equipment, as well as in guns and construction generally.

The applications of electricity on board ship are numerous and varied, and the electrical equipment may very properly be divided into two general systems; first, the system for the distribution of light and power, the energy for which is taken from the generating dynamos, assisted, may be, by accumulators; second, the system of "interior communication" between different parts of the ship. And finally there are other miscellaneous applications such as range finders, electric logs, &c., and which would come under a separate head of apparatus introduced for the purpose of perfecting the fighting and maneuvering powers of the vessel. Gun firing and torpedo circuits, for instance, would come under this latter head. The energy for supplying the system of "interior communication" is taken from primary batteries or accumulators. It is, of course, for the first system that nearly all the power is required, though some of the other applications are quite as important.

In our own as well as foreign naval vessels, the constant potential system of transmission is adopted for the distribution of light and power as best suited to the conditions. It is not the intention to discuss here the requirements of an efficient installation, suffice it to say that the fighting efficiency should outweigh all other considerations, and hence the paramount feature in laying out the installation; should be the maintenance of the supply of light and power without interruption, during an action or in naval maneuvers. To attain this supreme object, every means possible is, or should be, employed. As for instance—

1. The central station of supply containing the generating sets is located below the armored deck. Each unit consists of a compound wound dynamo generally multipolar) driven direct by a vertical engine on the same bedplate. The total capacity is such as will supply the maximum demand that is liable to be required at any one time either in action or when maneuvering. Interchangeability and small external field of dynamo are the principal features of the generating sets, besides other general requirements necessitated by the conditions found on shipboard.

2. If more than two generating sets are installed they should be operated in multiple on going into action.

3. The use of the double in preference to the single wire system.

4. The vital parts of the ship, such as the engine and fire rooms, magazines, shell hoists and motors for working guns, should be on mains of their own (called battle circuits), with no submain or branch wires leading into unprotected places. Feeders should be kept low down in the ship and vertical when possible.

5. Accumulators should be at hand in the vicinity of the dynamo room in order to supply the important lights in case of accident to the generating sets or failure of the steam supply.

6. A few oil lamps should be lighted in the vital parts of the ship on going into action, as well as the magazine candles, so as to avoid confusion in case the mains for those parts of the ship should become short circuited.

* The author acknowledges his indebtedness to London *Engineering* for a number of the illustrations used.

7. Conductors should have first-class insulation, in addition to being lead covered, particularly in order that the installation may be protected from the injurious effects of salt water and heat.

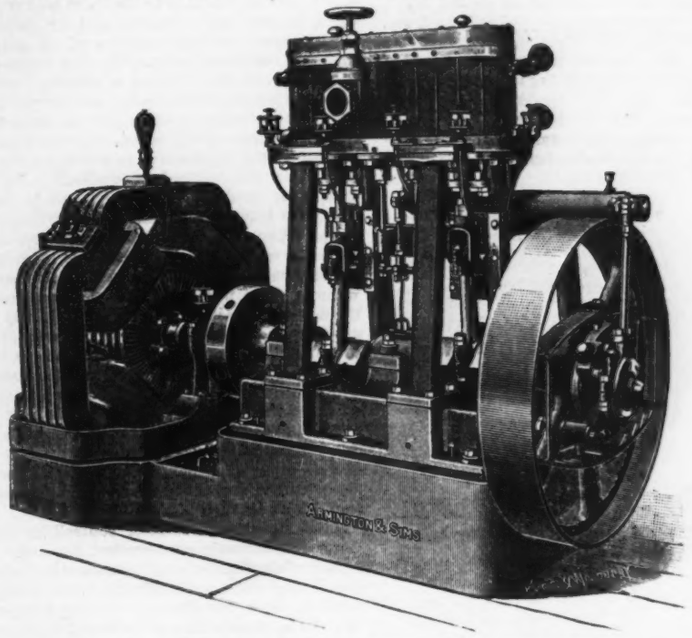


FIG. 1. GENERATING SET USED IN UNITED STATES NAVAL VESSELS.

8. Junction boxes, fixtures, switches, receptacles, &c., must be water-tight.

9. The engine room, fire rooms and other vital parts of the ship, each to have independent circuits from the dynamo room, instead of one feeder for all. This is extremely necessary, in order to control the different parts of the ship from the dynamo room.

Regarding the voltage, the standard on board ship should be that best adapted for the simultaneous operation of incandescent lights, search lights and motors.

In the United States, English and French navies, 80 volts is the standard pressure of supply. In the German, Russian and Italian navies, 65 volts is the standard.

Fig. 1 shows a favorite type of generating set used in United States naval vessels.

NAVAL PROJECTORS.

It is in the search light apparatus that the greatest development has been made of late years for increasing the efficiency of the electrical equipment of warships. The projector of Col. Mangin, of the French army, continues to be the most approved and efficient type for naval use. Metallic parabolic mirrors are common in the merchant service on account of their cheapness. Some of the foreign nations are using glass parabolic mirrors for land defense in their large projectors, the automatic lamps of which take very large currents. But for naval vessels the Mangin mirror is the favorite type for projectors.

This glass reflector possesses the same mathematical properties as the parabolic mirror and with absolute perfection in workmanship; moreover, from a mechanical point of view, its shape makes it well adapted to ships' use. The mirror is placed in the rear end of the drum and consists of a concave-convex lens, the convex surface having the greater radius. The concave side is turned toward the lamp and the convex surface is silvered. It is therefore a reflector; but the radii of curvature of the faces are so calculated that the two refractions at the concave surface almost completely destroy all aberration and this gain, more than counterbalances the loss by reflection. The projectors are mounted on a pivoted saddle and swung on trunnions, so that a movement of rotation about two axes at right angles is obtained. The carbon holders are not vertical, but set at an angle of about 30°, so that the light from the crater in the upper carbon is thrown directly upon the silvered lens at the back of the projector. In the hand lamp the carbons are fed together by a worm wheel underneath the lamp. Fig. 2 shows a naval projector with Mangin mirror and hand lamp.

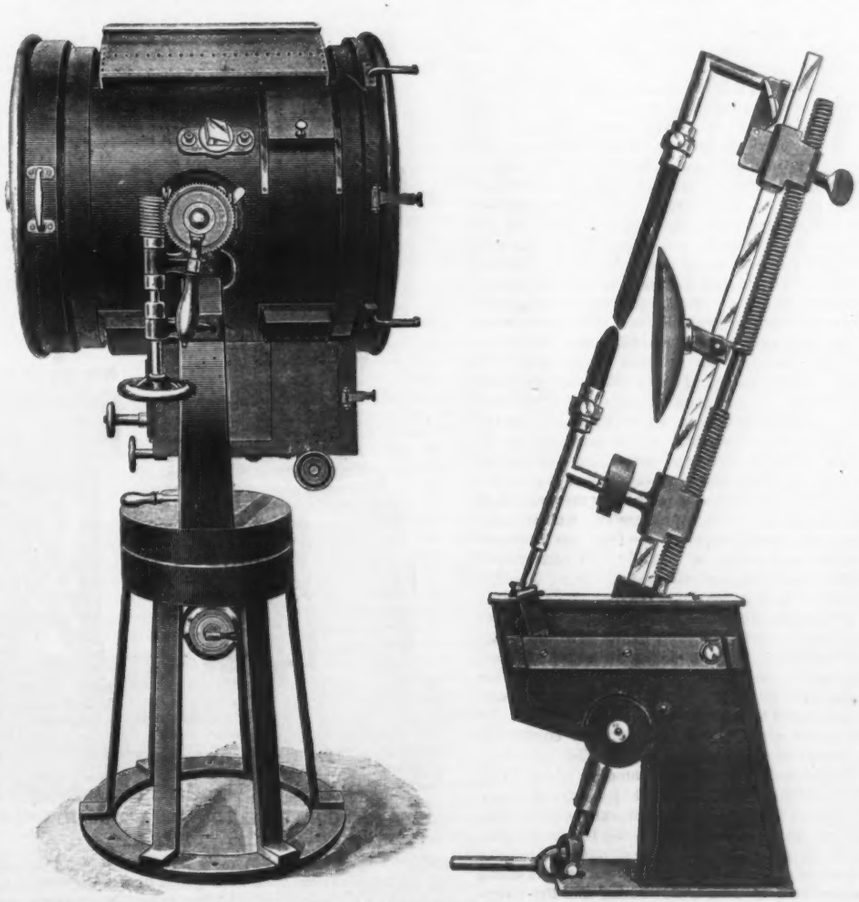


FIG. 2. NAVAL PROJECTOR WITH MANGIN MIRROR AND HAND LAMP.

Projectors fitted with hand control only have been used altogether on board ship until within the last few years. One man can handle the projector and regulate the carbons with ease, but owing to the blinding effect of the light, it is necessary to have a man stationed a few feet from it in order to direct the movement of the projector and discover objects which it may illuminate. It is now considered necessary to have naval projectors controlled electrically from a distance, and the lamp itself automatic. Where the distance from the operator is short, mechanical means of control for the projector will suffice. In all cases, however, the lamp should be automatic.

The necessities of modern warfare and the general adoption of Mangin projectors on shipboard have demonstrated the advantages that may be derived in distributing this means of defense in a systematic manner and according to the functions they are required to fill. Extensive experiments made during recent years by the naval authorities of different countries have proven that for warships generally, the construction, size, method of control and location of the projectors should depend on the nature of the service for which they are intended. The projector is primarily a weapon of defense. Occasionally it is used for offensive purposes. In the latter case we require search lights for distant points, giving a beam of the maximum concentration; in the former case we require projectors for short distances, the beam of which has, on the contrary, a large amount of horizontal divergence. As the projector is more frequently required for defensive purposes, the majority of those supplied to a ship should be with this view. This applies particularly to a large ironclad that would be subject to attack from torpedo boats. At least one, however, should be mounted in some elevated position so as to be available for offense, as, for instance, in a top on the foremast. The forward side of the mast, just above the upper bridge, is a most excellent location where the light can sweep well abaft the beam as well as forward, and on either side lights for the longest ranges are placed in the ship's tops and are protected by light armor clad inclosures. Those used for defense when long range is not required, are placed as near to the level of the water as the

construction of the vessel will permit, in such a way as to illuminate a large circle and thus afford the ship protection. The ideal illumination of this kind would be to surround the vessel with a protecting zone of light so broad and brilliant that no advancing vessel could approach without being detected and remaining illuminated for a relatively prolonged period. In order to establish a continuous zone around a ship it is necessary to reduce as far as possible the angle made by the beam with the sea; the best position in which the projector can be placed is therefore low down and outside the vessel or projecting from a port-hole. When the construction of a ship renders it possible, it is desirable that the projector should be placed beyond the side of the ship while it is being operated, if it is desired to give a wide angular range to the beam. A recent writer in the London *Engineering* describes very thoroughly the conditions for operating projectors on shipboard and the way in which these conditions have been met by the firm of Sauter, Harlé et Cie., Paris. These notes, together with the illustrations, have been utilized by the writer in the preparation of this article. The projectors for defense must not only be located low down, near the water line, but they must be provided with means by which the apparatus can be withdrawn through the port hole, or other opening, back into the ship when the condition of the sea or hostile fire renders its position dangerous. The drum of the projector and its various supplementary parts have to be designed in such a way as to reduce its dimensions as much as possible. On the other hand, direct control of the projector is impracticable, and a system of controlling the angular (vertical) and horizontal movements of the apparatus from within the ship either by mechanical or electrical means becomes a necessity. And in order to obtain the most useful service from the luminous beam, means must be provided to concentrate or cause it to diverge at will, according to whether it is desired to illuminate a particular spot or a wide zone. The range of divergence ought, therefore, to extend from a minimum corresponding to the greatest concentration, up to a maximum amplitude sufficient for the zone that is to be illuminated. This variable divergence can only be produced by mechanism placed behind the projector.

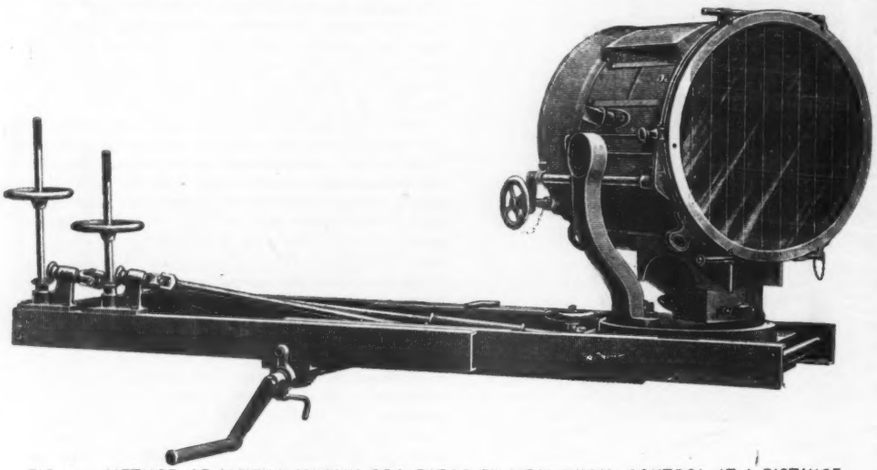


FIG. 3. METHOD OF MOVING MANGIN PROJECTOR BY MECHANICAL CONTROL AT A DISTANCE.

The means adopted for fulfilling the conditions just enumerated, are as follows: The projector (Fig. 3) is mounted on an iron frame, to which a forward movement can be imparted by means of a rack and pinion. The base of the projector carries four rollers, on which it can travel along the frame that is made of U irons; a locking bolt fixes the base in any desired position. The movements of the drum are controlled by two handwheels, and the transmission is effected by universal joints and two spindles provided with coupling sleeves; the bed-plate and the projector are moved to and fro by bevel wheels and an endless screw. The dimensions of the complete apparatus for a 60-c. m. projector are 1.03 metres in height and 810 m. m. in width. The optical system giving the variable divergence of the beam consists of two dispersion openings provided with plano-cylindric lenses, alternately concave and convex. One of these openings can be moved forward long tudinally by means of an endless screw controlled by a handwheel placed behind the drum, one on either side. The other opening is fixed. In turning the handwheels in one direction or the other, the moving opening is passed in front of the fixed one; the lenses are calculated in such a manner that their partial overlapping widens or concentrates the beam. In one of the extreme positions the concentration is at a maximum,

FIG. 4. MANGIN PROJECTOR AND REGULATOR FOR ELECTRICAL CONTROL.

and the angle of the beam does not exceed 2°; the ray is then identical with that given by a projector inclosed by a plane glass, and the zone, illuminated at a range of 1,000 m., gives a width of 35 m. In the other extreme position the dispersion amounts to 20°, and the path illuminated at a distance of 1,000 m. would have a width of 350 m. (60 c. m. projector); the intermediate rotation of the handwheel produces all the intermediate positions. The apparatus is operated, either at its own level by means of the handwheels mounted on the spindles, or at a higher level, as for example on the upper deck, by means of intermediate gearing and extended shafts. As soon as the port hole is opened the apparatus can be run outboard by turning the hand lever controlling the pinion which gears into the rack; the clutch controlling the movement of the projector is then thrown in, and the base of the projector is locked to its frame; the current is then admitted to the automatic lamp. In order to vary the divergence of the beam, the operator places himself behind the drum on one side or the other, and turns the vertical handwheels. In heavy weather it would often be impossible to keep the port holes open and the projector would, moreover, be exposed to damage from the sea. It is necessary under such circumstances that the projector should be easily removed to the upper deck, where a spare pedestal would be provided, with the necessary electric conductors. It is only necessary then to slacken the jaw which holds the base to the carrier that travels on the frame, to hoist it and secure it in its new position. The two handwheels are then mounted on the controlling spindles that pass through the case and which may be arranged in a convenient manner; the projector is then operated the same as before, except that the movements of the drum are controlled directly by hand, instead of at a distance through the intervention of rods and gearing.

It is evident that instead of controlling the projector mechanically as described, we could use a system of electrical control if desired; the actuating electric motors being placed either close to the projector so as to act directly on the transmission spindles or on an extension if found more convenient. In fact nearly all naval projectors now supplied to modern warships, particularly those vessels intended for the line of battle, are required to be fitted with the electrical system of control at a distance.

The advantages secured by a system of control at a distance are summarized as follows:

1. Lights may be placed and controlled in any difficult or exposed position, such as the top of a ship; and the light so placed can be controlled from any convenient and protected place at a distance.

2. The responsibility of directing the projector is in the hands of one man, so that the captain of a vessel can control the search light himself.

3. The projector can be fixed in positions that would otherwise be impossible.

4. There is a considerable reduction in the number of persons employed with a corresponding reduction in the chances of error.

The system of controlling search lights at a distance has been perfected by MM. Sauter & Harlé only after long investigation and numerous experiments. The conditions to be met were as follows: In the first place it was necessary that the lamp should be automatic, and in place of the hand lamp the mixed type designed by this firm was substituted. The general features of the combination lamp are that it can be worked either automatically or by hand as desired; by the simple movement of a switch the carbons are brought together, the arc struck and the feeding goes on automatically; the feeding mechanism is independent of gravity. It was necessary that the mechanism employed for directing the projector should work with perfect smoothness and accuracy and that it should be able to direct the light exactly on any desired point. The importance of this will be understood when it is remembered that the concentrated beam from a Mangin projector has a divergence of but 2°. Rapidity of research is essential and combined with this must be the facility of controlling by hand both vertical and horizontal displacements of a relatively considerable range. Another condition of vital importance is that the apparatus can be stopped instantly and at any required spot, so that a full beam can be thrown

and kept upon the object to be illuminated. Arising from the last named requirement is another of but little less importance. When once the object being sought for has been brought under the beam, the power for rapidly moving or stopping the mechanism must be supplemented by the means of moving the projector up and down or to and fro, almost imperceptibly, so that the object under examination may be exposed in detail to the beam; and it is, therefore, necessary that the person controlling the light must be able to apply the fastest and the slowest movements, as well as to stop the mechanism instantaneously. As a last addition it may be added that facility should be given for changing the control at a distance for the ordinary hand control; this has to be effected instantly by means of a clutch. These numerous and complicated conditions have been met in the following general manner:

When the available space permits of mounting the projector on a pedestal, the mechanism is placed on this pedestal or base. An electric motor controls, by means of two magnetic clutches, two horizontal spindles which give the angular movement to the projector; the magnetic clutches consist of two pairs of electromagnets, turning freely on each horizontal spindle. When a current is passed, these magnets attract a disk of iron held on the shaft by friction and turn it in their movement with the shaft itself. As the electromagnets turn in opposite directions, by means of the gearing and by one pair of magnets, the horizontal motion is obtained, and with the other pair the movement of inclination is secured. The transmission to the drum of the projector is effected by means of tangential screws and bevel gear. The current for the motor is derived from the same source as that which supplies the lamp. The apparatus is connected to the point of control by a multiple cable. The manipulating board at the central station comprises: A two-way commutator for controlling the rise and fall of the beam, a two way commutator for directing the horizontal movements to the right and left and a commutator for starting and stopping the electric motor. The lever of this latter passes over a series of contacts, by which a corresponding set of variable resistances are thrown into the circuit; by this means the movement of the projector can be accelerated or retarded at will. The last one of the series regulates the fine adjustment of the beam; the very small angular displacement produced by it is maintained as long as the contact is kept. The conductors are all contained in one cable; they convey the current to the lamp and to the mechanism controlling the projector. It will be readily understood that by disengaging the clutches before spoken of, the system can be at once changed from that of control at a distance to hand control. This development enables the operator to pass from the most elaborate to the simplest system of control. This system of electrical control is applicable to all sizes of Mangin projectors, and, as before stated, if the mechanism cannot be set in the base it is easy to set it upon a separate base plate and transmit the various movements by means of connecting rods. For the large sizes of projectors the means of controlling them at a distance is especially advantageous, on account of the restricted space available in the tops of battleships.

(To be continued.)

European Rapid Transit Practice.

(Concluded from page 533.)

FREIGHT SERVICE.

Freight trains are not allowed upon the main line during the day. On the south and north Rings they are permitted, as in this way alone can they reach a number of the freight stations. At the present time work is going on which, when completed, in four or five years more, will give to both north and south Rings a complete double track freight service, entirely distinct from the passenger lines.

The main line serves to supply the central market of Berlin. Cars filled with food supplies, other than live animals, arriving during the day are kept on side tracks on the Ring lines until midnight, when, with such other provision cars as may have arrived during the evening, they are brought to the side tracks of the market near the center of the city. Here they are immediately unloaded and their contents let down on large hydraulic elevators to the main floor of the market, which is on a level with the surface of the ground. The supplies thus received and delivered aggregate from 120 to 160 carloads each night. The side tracks of the market will not accommodate more than 40 freight cars at a time, hence when unloaded they are immediately taken away to make room for others. When, a few years ago, this market method was introduced to take the place of the general sale of produce from carts, it aroused great opposition, which has now, however, wholly died out, from the discovery that by the new method the prices of food supplies have been sensibly reduced. The market is owned and stalls leased by the city, but the management of the market traffic, until the produce comes within the walls of the market, rests in the hands of the State officials.

The same system obtains in the management of the Berlin slaughter-houses, which are located on the North Ring, and at which as many as 19,000 head of animals of all kinds have been landed in a day (the average daily supply is 30,000). Here, too, the service of delivery is largely performed at night; though when the special freight tracks are completed this will not be in the least necessary.

THE LONG DISTANCE PASSENGER SERVICE

on the Stadtbahn is confined to trains going east and west; those railroads running northward or southward from Berlin having their own main stations, though connection can be made with their line by one or the other of the Ring roads. It is probable, however, that this method is not often employed. But the trains running east and west from Berlin pass over the Stadtbahn. The trains going east start usually from the west end of the city, stopping for two or three minutes' time at three or four of the main stations on the route. Similarly long distance trains for the west start from the east end of the city, and take up their passengers as they proceed westward over the Stadtbahn.

While this railway system is of great strategical value to Germany, giving an advantage, it is said, of at least one day in the mobilization of the army, it was originally planned both by MM. ORTH and HARTWICH with an eye to ordinary rather than extraordinary purposes. Its construction was first undertaken by a company formed for the purpose, which was to be assisted by the government, and it was only when this company failed to keep the engagements it had made that the national government took up and finished the work.

THE LIVERPOOL ELEVATED ROAD.

This new overhead railway in process of construction is owned and will be operated by a private company, which has acquired the concession from the Liverpool Dock Board (which is in substance a branch of the city government, such, for example, as the Boston School Board is) for a period of 999 years. By the terms of this concession the railway company pays to the Dock Board a ground rent agreed upon for the land occupied by it, and agrees to divide its profits with the board after paying 5% per annum to its shareholders. The Dock Board reserves the right to terminate the lease at any time by the purchase of the structure and equipments at an agreed valuation. The road will be put in service in about a year. It will be operated by electricity, the cars taking it from a wire fastened to the structure. It is the first elevated railway, so called, that has been built in Great Britain, and the estimated cost of construction and equipment is $400,000 per mile.

It runs at the side of and on the line of Regent's Road along the water front of the entire city, but is almost entirely within the boundaries of the Dock Board property. Its length when completed will be 6 miles. The structure is ordinary post and girder, providing for two tracks; the landing places are to be at the entrance of each dock yard. These will apparently be little more than open platforms. Where the track of necessity extends over the public street the company agrees, in consideration of no further charge, to pave, light and keep clean the street at these points. The speed at which it is proposed to run the cars on this line is 25 miles per hour.

TERMINAL STATIONS.

Although there can be no doubt that in the facilities for long distance travel the railroad companies of this country have little or nothing to learn from experience of railway companies in Europe, it is almost equally certain that in the handling of short distance passenger traffic, in the construction of terminal stations and in the utilization of terminal facilities, the European (particularly the English) companies are as far in advance of the American as the American companies are of the European in long distance travel. Their stations are better arranged for business, their light compartment trains are possibly better adapted for quick movements, while in the handling of their engines, trains and passengers their methods are so far superior to ours as to be almost beyond comparison.

The North London Ry. having its station on Broad St., is a strictly local road, devoted to suburban business. During the month of August it sent out and received each day at this station, on the average, 620 passenger trains, 35 empty trains, 20 light engines (engines without trains), and 70 goods trains—in all nearly 750. It sends out and receives each year more than 40,000,000 passengers—that is, more than all of the steam railroads of Boston combined. These are received and dispatched in a station having 9 bays or tracks. Near the entrance of the station there is a short siding to each track, simply long enough to hold a locomotive, which can there receive the water and fuel it needs. When a train from the suburbs enters the station and the passengers have alighted, the engine on this siding draws out and connects with what was the rear end of this train, and after a wait of 5 or 10 minutes, as the case may be, this train starts out upon another trip. The engine that brought it in then backs down, enters the siding and is in readiness to take out the next train that enters the station on that track. The trains are kept running like shuttles from morning until night between the country and the city stations. The time for the departure of a train is placed at from 5 to 10 minutes after its arrival, whether that arrival is morning, noon or evening. There are, as the term "Empties" used above indicates, a few extra trains put on in the morning and evening when the pressure of travel is greatest; but these are apparently kept, when not in use, at suburban stations, rather than at the city station. A short distance outside of the station the tracks are reduced to 4, these falling to 2 after several branches have been passed.

A mile outside of the London station is located a signal office, from which, by dial, the signal man in the box immediately in front of the station is notified of the train that is approaching. On receiving this information he signals to the station to know whether the regular track or bay for the coming train is ready for its reception. If it is so, the train is shunted by ordinary methods into its proper place; but when once there, by an automatic process worked by the train itself that bay is locked, and no other train can be shunted into it until the first train has left. The traffic manager of this road asserted that if he attempted to follow the American method in making up and dispatching his trains his business would be thrown into hopeless confusion. In order to do his business he must keep his trains moving, and while absolutely necessary to prevent congestion, it was about as cheap as to have them stay idle. The trains are cleaned out by light brushing when in the stations, probably oftener at the country than at the city station. But the foreign method of having the stations built with broad platforms and glass roofs, and the opportunity to enter the cars from the sides, probably tend to facilitate this work.

The Great Eastern Railway, at its station in Liverpool St., London, takes in and out a larger number of passengers than enter and leave any other railway station in the world. The daily average this year has been over 170,000, or say, including Sundays, 55,000,000 in a year, against an annual average of 40,000,000 for all the stations of Boston. In spite of its great business, this company has the highest record in England for prompt arrivals and departures. The greater part of its passengers come in and go out by its suburban service. For this it has at its station 9 lines of track, with 5 others for its long distance trains, the latter entirely separated from the former. These suburban trains are received and sent out in the same manner that trains in the North London station are handled, 40 coming and leaving in an hour in the busy part of the day, the average for the day being 520. The suburban trains to this station stay there hardly more than 5 minutes. The long distance trains, which are made up and brought into the station in much the same way that our American trains are, stay there for a half hour or more. The company has for some distance from its station 6 lines of track. Although its passenger business is large, the company has never paid to its shareholders more than 3½ per annum in dividends. This is due to the immense obligations to which the so-called railroad king, HUDSON, committed the company nearly 50 years ago, in constructing a large number of unprofitable lines in the eastern part of England, lines which have never yet paid expenses. But the company believes that its future welfare is to be found in encouraging the profitable and growing part of its business, that is, its suburban service, which has lately increased at the rate of about 15% per annum. On this account, in spite of its strained financial condition, it has raised and is now spending $10,000,000 in enlarging and improving its Liverpool St. station, for the purpose of better accommodating its suburban service. While the average fares are about a penny a mile, this road is compelled by act of Parliament to run a workingmen's train out and in for 20 miles, on which the fare for a part or the whole of the distance is one penny. A season ticket for a year, unlimited as to use, is sold, second class, for a four-mile run, for about £5, or $25.

The St. Lazare station in Paris of the Railroad of the West is the one which corresponds nearest to the two stations in London just referred to. To show the increase that has taken place in its suburban business it is only necessary to say that in 1838 the number of local trains in and out was 72 daily, and passengers carried 6,138,644 yearly. In 1890 the number of local trains had grown to 366 daily and passengers to 26,301,617 each year, these figures covering merely the suburban service. During the time of the French exposition as many as 225,000 persons often used the station in a day. The company owns and operates a line which runs completely around Paris, just inside of the walls of the city, and beside this has lines running to Versailles, St. Cloud, St. Germain, Argenteuil, Pontoise and other suburban towns. In this respect no other French railroad can compare with it. The St. Lazare station is an immense building upon which the company has recently spent more than $1,000,000 in the way of en-

largements and improvements. In this station there are 25 tracks, 16 of which are devoted to suburban business. The arrangements made for receiving and sending off suburban trains differ somewhat from the methods in use in London. When a train arrives it runs into a bay in the station which has 2 tracks. At the end of each of these bays, nearest the head house, is a small turntable and a shifting platform, both operated by hydraulic power. The engine is turned and shifted to the parallel track in less than a minute's time, and if that track is vacant it can go out and back down to the other end of the train it has just brought in, or, if the track is occupied, it can go out just so soon as the train which stands in the way has left. This method is considered in Paris better than the London one, as the engines are turned, and a transfer of them from train to train is made unnecessary. Some idea may be formed of the magnitude of the work performed at St. Lazare from the statement that there are regularly employed there, for strictly station purposes 700 persons, who are each paid, on the average, from $250 to $300 per annum. On holidays and other special occasions the number is increased to about 1,100. This does not include freight work, except what is called express freight, that is, that which goes with passenger trains. At St. Lazare, as with other great railroad stations in Europe, a large use is made of hydraulic power for passenger and freight purposes. Where the stations proper, as is often the case, are above the grade of the street, hydraulic elevators are used to take the trunks of the passengers up and down, as these are ordinarily received and delivered in rooms on the street grade. With freight, two floors of a freight station are often utilized. The freight cars are hoisted by hydraulic power to the second floor, and by means of turntables and winches worked by hydraulic force are easily carried to any point that may be desired, while cranes furnished with the same power quickly transfer the contents of the cars to the teams or that of the teams to the cars. In a word, a use of mechanical power is made in these matters, which I think is to a great degree without its parallel in this country.

ENGINE HOUSES.

In such matters, too, as the storage and repair of locomotives it has been found that the old-fashioned "round-house" is uneconomical, because it occupies too much ground for the accommodation it gives. The new engine houses are, therefore, made rectangular, with lines of parallel track and with small turntables and shifting platforms worked by hydraulic power wherever these are thought necessary.

RATES OF FARE—THE ZONE SYSTEM.

The railway systems of Europe were perhaps never so greatly and immediately influenced by any action as by that taken by M. Baross, the Hungarian minister of commerce, in establishing the so-called "zone" method of fares. The result in his case, as is well known, has been a wonderful success. The railway patronage of the kingdom of Hungary has increased in two years from the rate of about 4,000,000 to the rate of nearly 20,000,000 persons per annum. The receipts have, of course, increased, but nowhere near in the proportion of the passengers. This result has naturally attracted a wide attention, and wherever the railways are under government or semi-government control a similar movement for a revision of fares has been begun

In Austria it has been in part carried out, and in a few months more the new minister of railways of Germany will probably report a plan of fares for the railways of that empire based on the general principles of the zone method. At least the statistics needed to enable him to arrange such a plan are now in course of preparation. For the suburban service of Berlin the theory has already been accepted, and it is only a question of how far to extend the opportunities for travel afforded by the present rates of fare for short distances. In Paris the question of rates of fare is complicated by a tax imposed by the government, and the companies are desirous of having this modified or removed before moving in the direction of lower rates.

M. Baross said that he wished to do away with a misapprehension to which the term zone had given rise. The fares were graded, not by districts, but by distances. In his plan any station was the center of the system. He wished to sell tickets from any station in the kingdom for 10, 20, 30 or more miles of continuous travel at the same prices as tickets for similar units of distance were sold elsewhere. At the present time, for financial reasons, the system centers at Buda-Pesth, and on this account one traveling from the eastern to the western end of the kingdom is compelled to buy a ticket to Buda-Pesth, and from that city onward. But this qualification is made because it was thought too much of a risk to apply the scheme at first in its entirety; for, as all traveling beyond a distance of, say, 140 miles is free traveling, it was feared that, for a time, the revenue derived from the roads would be reduced to an inconveniently low point; that is, that with such an inducement long distance travel would increase at a more rapid rate than short distance travel. By the break in the system established temporarily at Buda-Pesth, an opportunity is afforded for the business to adjust itself to its new conditions. The plan was vigorously condemned in advance by all of the practical men to whom it was submitted, and no amount of persuasion on his part could have induced them to accept. Those who are now in some mild measure copying it have been forced so to do solely by the results of its application for the last two years.

CULTIVATING SUBURBAN TRAFFIC.

It can be said that the supporters in Europe of the "zone" system, when applied to suburban districts, point out that there is no better investment that a company can make than to build up a suburban population on its line from 5 to 20 miles out from its metropolitan terminus. These are ordinarily dependent on the city, they are too far out to be easily taken by tram cars of any kind, and within this short range the value of land is so high that the building of competing steam lines is almost impossible Thus each new settler gives to the railroad company the promise of a constant and possibly increasing in come. The present policy of most of the European railway companies is to give special encouragement to the form of business. This is shown by the tendency to increase the number of trains, to systematically reduce this rates of fare, to make special, inducements in the way of commutation tickets, and to freely spend money in enlarging terminal facilities. As to commutation tickets, it may be pointed out that, while in this country the disposition exists to surround them with all manner of qualifications, in Europe there is an obvious disposition to favor the holder of one in every way. He may ride as frequently as he pleases during the period the ticket is in force, and opportunities are freely afforded him to extend it without charge, if for any reason he cannot use it during the specified time. As to the construction of new or the enlargement of old terminal stations, changes which in almost every instance are caused, not by the pressure of long, but of short, distance travel, these are held to be both imperative and useful investments, on the ground that a great increase of this class of business is one of the best guarantees of the future welfare of the corporation, and unless a company proposes to have its business remain stagnant it must provide adequate means of taking care of it.

This valuable report is concluded by some remarks on the bold street improvements of many European cities, which we have heretofore fully described.

The Gibbs Steam Hose Coupler.

In our statistics of the progress of steam car heating, published in our issue of June 7, 1890, the Gibbs coupler for the steam hose between the cars was reported in use on the Milwaukee & Northern and Baltimore & Ohio roads only; since that date its growth in popularity has been exceedingly rapid, and we are informed that it is at present in use on 32 prominent railways, controlling over 43,407 miles of road and 13,301 passenger cars.

The coupling is of the same type as the Westinghouse brake coupling, and its operation is therefore familiar to trainmen. It uncouples automatically, hangs below the air brake coupling, and when being coupled has no pressure between the gasket faces or steam joints and hence no wear to cause leakage. The two halves of the coupling are exact counterparts of each other and are therefore perfectly interchangeable. Wear does not affect this interchangeability. Fig. 1 is a longitudinal section of the coupler head, from which its working and mode of construction may be readily seen.

It has been objected to couplers of this type that they offer great resistance to the passage of steam. To test this matter the makers of the Gibbs coupler had experiments made by two mechanical engineers, Mr. Geo. L. Fowler and Prof. Jas. E. Denton, of the Stevens Institute of Technology. The experiments consisted in arranging six Gibbs couplers with their regular hose attachments in line, as shown in Fig. 2, and blowing steam through them. A second line was also arranged with steam couplings of the "straight-ported" type, but with hose and unions the same in every respect, as in the first line.

Mr. Fowler, in a report dated June 2, 1891, said he found that with the Gibbs coupler a pressure of 28½ lbs. was required at the left hand end of the line to give a pressure of 20 lbs. at the right hand end (steam being blown into the atmosphere at the right hand end through an orifice ⅝ in. in diameter). The average reduction of pressure was, therefore, $1\frac{1}{12}$ lbs. per coupler. With the straight ported coupler, the pressure at the head of the line necessary to maintain 20 lbs. pressure at the exit was 33½ lbs., or 2¼ lbs. reduction per coupler. The reason for the freer delivery of the Gibbs coupler, notwithstanding its less direct passage, was the greater size of the passages. Fig. 1 shows the sectional area for the passage of steam at the most contracted sections. The rate of flow of steam through the line was about 550 lbs. per hour.

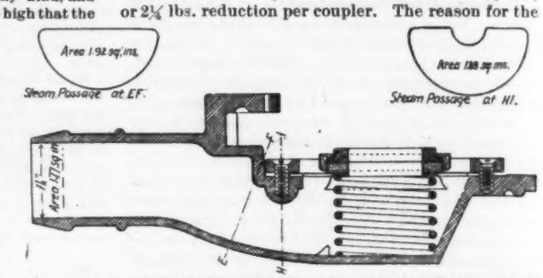


FIG. 1.—LONGITUDINAL SECTION OF GIBBS STEAM HOSE COUPLER SHOWING AREAS OF STEAM PASSAGES.

Prof. Denton's report of similar tests, made June 9, 1891, showed that with the Gibbs couplings 27 lbs. was necessary at the head of the line to maintain 20 lbs. at the exit. With the straight-ported coupling 34 lbs pressure was required, showing, as in Mr. Fowler's tests, that the resistance of the Gibbs coupling was about half that of the straight-ported coupling.

The Gibbs coupling is controlled by the Safety Car Heating and Lighting Co., 160 Broadway, New York.

The Glasgow Tramway System.

The Glasgow Tramway system is to be hereafter "managed and controlled" by the corporation. The system is 31 miles long, carries over 50 million passengers per year, and was built by the corporation at a cost to date of about $1,750,000. The system was leased in 1871 for a term of 23 years to a private company for the interest on the outlay, 3% for a sinking fund, 4% for renewals and a rental of $750 per mile of city street. The renting company paid, in recent years, about $150,000 per annum, and have paid in all to the corporation the sum of $2,443,815. But the renters have also paid a dividend of $130,000 per year, or about 8⅓% on the called capital. In the year of the Glasgow Exhibition the dividend was about 11%, but recently the profit has considerably fallen, due, perhaps, to the near expiration of the lease.

The Glasgow rate payers, attracted by the hand-

FIG. 2.—ARRANGEMENT OF HOSE COUPLINGS FOR EXPERIMENTS ON THE FRICTION OF STEAM.

some returns, demanded that the city operate the system itself, and in stating terms for the renewal of the lease so many onerous conditions were added that the corporation is now in charge and will operate the lines. It is the intention to experiment with mechanical motors. There is already a demand for shorter hours of labor and lower rates of fare (now from 2 to 6 cts. per 4 miles), and the returns to the taxpayers may not be as large as they expect under the new order of things.

AT AN EXHIBITION of the locomotive at the Thomson-Houston works, at Lynn, Nov. 28, six loaded freight cars, with a total weight of 163¼ tons, were hauled with apparent ease. One report states that this load was hauled "over a grade of about 3% and a curve of 150 ft. radius;" but this seems rather doubtful. The power was not taken by a trolley from a wire in these tests, but a heavy cable was attached to the locomotive and dragged on the ground as the locomotive moved.—The Thomson-Houston Co. have just completed an 80-H.P. mining locomotive for the Forest City, Pa., Coal Co. The machine weighs 11 tons, and stands only 83 ins. high.

PETROLEUM BLOCK FUEL was recently tested in England, says *Herepath's*, with the following results: The blocks were prepared according to "Chenhall's patent," with 10 lbs. of crude oil forming an 18 lb. block, and this block is converted from the liquid to a solid form in ¾ hour, at a cost of about 1½ cts. per block, and the block would burn for about 3 hours. The saving in cost as compared with coal is estimated at 10%, and the relative saving in bulk is very much in favor of the block fuel, a point well worth considering in coaling a ship. No information is given as to the material used with the petroleum, or as to the method of manufacture; but the report says no clinkers or refuse remained after burning. Sir EDWARD J. REED, M. P., is said to have pronounced the process a complete success. The inventor is Mr. W. S. CHENHALL, Mining Engineer and Chemist.

ALASKAN COAL MINES, it is stated, will soon be in condition to supply California and other Pacific States with fuel. During the last three or four years parties have been developing the coal mines located on Niga Island, the principal one of the Shumagin group, about 900 miles west of Sitka, and will be able to place coal on the market next year. The coal veins lie one above the other, about 30 ft. apart, and number from four to six workable veins of from 5 ft. to 6 ft. in depth. They can be traced for a distance of two miles. A tramway has been built connecting the tunnel with a 350-ton bunker at tidewater, where wharves and dwelling houses have been erected. It is stated that the coal is virtually inexhaustible, and of a quality somewhat superior to Seattle, Wash., coal; but being of lignitic formation it carries a large percentage of moisture. It is asserted that cargo lots can be delivered at San Francisco at $4 per ton.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Orford Mountain.—This 10-mile railway from Eastman to Lawrenceville, P. Q., has been completed, and inspected by the Provincial Government officials.

Grand Trunk.—Surveys are in progress for a 5-mile branch from Midland to Perkinsfield, Ont.

Portland & Rumford Falls.—Between 10 and 11 miles of the 14-mile extension to Rumford Falls, Me., have been completed, and it is expected to have the entire distance graded and bridged by Jan. 1, 1892. There are rumors of a proposed extension, possibly under another name, from Rumford Falls up Swift River to Houghton's, near Mooselookmeguntic Lake.

Altoona & Wapsononock.—This company has issued $60,000 of bonds to provide for the completion of its line to a connection with the Cresson, Clearfield County & New York Short Route at Fallen Timber.

St. Lawrence & Adirondack.—This line has been completed from Valleyfield, P. Q., to Malone, N. Y., and will soon be put in operation.

Sandusky, Columbus, Lake Erie & Southern.—It is stated that the Lake Erie Construction Co. has taken charge of the work of building this line from Bellevue, O., south, and that construction will be rapidly pushed. The line is already completed from Sandusky, to Bellevue, O., 15 miles.

Rockaway Valley.—The right-of-way has all been secured for the extension from Mendham to Morristown, N. J., and it is stated that the work of construction will soon be commenced.

Findlay, Ft. Wayne & Western.—It is stated that this company will make a survey for a line from Findlay, O., east to Greenwich, O., 60 miles.

Odessa & Middletown.—Work has been begun on this short railway from Odessa to Middletown, Del., 4¼ miles, with a force of about 60 men.

Baltimore & Ohio.—The old project of this company to build a line from Wilmington, Del., to Cape May, N. J., about 82 miles, is again being discussed. The object of the line is to afford a short route for the Southern passenger traffic to that point.

Lehigh Valley.—A branch line will be built to the cement lands near Springtown, N. J.

Philadelphia & Reading.—In connection with the terminal at Philadelphia, this company will construct two short branches and do considerable other work to facilitate access to the terminal lines. The Chestnut Hill branch will be extended to Glenside, on the North Pennsylvania R. R. A loop will be formed in this way. Local trains on the North Pennsylvania road will return by way of Chestnut Hill and Germantown, and Chestnut Hill trains, instead of making that their terminus, will go on to Glenside and return by way of Jenkintown. It is expected that the train service will be largely increased on this loop, and that it will give the best kind of rapid transit to the large population along the two lines. The other projected extension, whose construction has been finally determined upon, will be to Frankford. The short link to be built to connect the Newtown R. R. with the Reading tracks near Logan Station will form a part of it. After leaving the Newtown road the new branch will strike for Frankford, and, extending beyond that, will form a connection with the Belt Line, near Butler St. A connection will be made between the Belt Line and the Richmond Branch tracks, and in this way a loop line will be formed between Wayne Junction and Frankford, giving all that part of the city quick access to the center of the city over the Reading Terminal.

Webb Mountain.—Geo. D. Webb, of Marlboro, N. H., writes us that this road is about 8,000 ft. long and runs from the main line of the Fitchburg R. R. to granite quarries owned by him in the vicinity of Marlboro. The road will be used entirely to transport granite. It has a maximum grade of 5% and a maximum curve of 12°. A. S. Cheever, Chief Engineer of the Fitchburg R. R., made the surveys.

Projects and Surveys.

Lake Hopatcong, Boonetón, Morristown, Caldwell & New York.—This line is now being located from Caldwell to Rockaway, 17 miles, with a branch to Morristown, N. J., 7 miles. H. C. Reynolds, Whippany, N. J., Secretary; C. C. Vermeule, 71 Broadway, New York City, Chief Engineer.

Crescent Connecting.—Chartered in Pennsylvania to build a railway from the Delaware River to Boothwyn Station. Albert P. McDowell, Philadelphia, Pa., President.

Maine Shore Line.—The maps, profiles and estimates have been completed for this Maine railway and will soon be submitted to the capitalists interested.

Crystal Lake.—Chartered in Michigan to build a railway from a point on the Toledo, Saginaw & Muskegon R. R., in Montcalm Co., Mich., to Crystal Lake, Mich., 7 miles. Among the incorporators are: E. W. Dodge, Owasso, Mich., and L. A. Lyon, Carson City, Mich.

Sugar Run.—W. J. Lewis, of Coudersport, Pa., President, writes us that the surveys are nearly completed for this proposed railway, from Sugar Run Junction to Sugar Run Station, 12 miles, and that work will be commenced immediately. F. W. Dalrymple, of Bradford, Pa., is Chief Engineer.

SOUTHERN.—Existing Roads.

Baltimore & Ohio.—Contracts have been let for building the Morgantown extension from Uniontown to Smithfield, Pa., 22 miles.—Engineers are locating an extension of the Valley Branch from Lexington to Glasgow, Va., 16 miles.

West Virginia & Pittsburg.—Tracklaying has been begun on the extension from Braxton, W. Va. to the Gauley River.

West Virginia Central & Pittsburg.—Tracklaying has been nearly completed on the line from Elkins to Bellington, W. Va., 17 miles.

South Bound.—A meeting of the stockholders of this company will be held Dec 8, to consider, it is rumored, an issue of new stock to provide for the construction of an extension from Columbia to Monroe, N. C., about 60 miles, and the building of terminals at Savannah, Ga.—The citizens of St. Mathews, S. C., are endeavoring to secure the construction of a branch from the main line to that place, a distance of 18 miles.

Bristol, Elizabethton & North Carolina.—The rails for this line from Bristol to Elizabethton, Tenn., 20 miles, have arrived, and tracklaying will begin at once.

Charleston, Sumter & Northern.—The Charleston, Colleton & Berkeley R. R. Co. will be chartered in South Carolina, supposedly in the interest of this company, to build a railway from Eutawville, S. C., to Charleston, S. C.

Sylvan & Webster.—The grading is nearly completed on this line from Sylvan to Webster, N. C., and tracklaying will soon begin. H. M. Ramseur, Webster, N. C., Chief Engineer.

Starke & Sampson City.—R. F. Ensey, Starke, Fla., writes us as follows:

The road is projected to run from Starke, Fla., on the Florida Central & Peninsula R. R. to Sampson City, Fla., on the Georgia, Southern & Florida R. R., a distance of 7 miles. The grading has been completed, with the exception of ¼ mile, and the contracts for crossties let, but work has been temporarily discontinued. The work is generally easy; maximum curve 5° and the maximum grade 1%. The principal business of the road will be in lumber, turpentine and the general freight and passenger business. It is uncertain when the road will be completed, but probably about February or March, 1892.

Projects and Surveys.

Orangeburg.—The Orangeburg S. C. Board of Trade has appointed a committee to prepare a charter for this company to build a railroad from that place east to a connection with the Charleston, Sumter & Northern R. R., and west to a connection with the South Bound R. R.

Charleston, Batesburg & Western.—A bill is before the South Carolina Legislature to incorporate this company with power to build a railway from Batesburg, S. C., to a connection with the Barnwell, Alston & Newberry R. R. Among the incorporators are John J. Huit, A. X. Gunter and N. A. Bates.

Gainesville & Sampson City.—A mass meeting of the citizens was held at Gainesville recently at which it was decided to build a railway from Gainesville, Fla., to a connection with the Georgian Southern & Florida R. R.

St. Augustine Belt.—A press dispatch says:

The proposed belt road at St. Augustine, Fla., has been made an assured fact by the action of the City Council in accepting the bond the construction company offered to give for the fulfillment of its contract.

Alabama Grand Trunk.—It is reported that contracts will soon be let for building this railway from Montgomery to Sylacauga, Ala., about 60 miles.

Fordsville, Hartford & Southwestern.—John J. McHenry, Hartford, Ky., writes us as follows:

The surveys for this railway, which is projected to run from Fordsville to Hartford, Ky., and thence to a connection with the Chesapeake, Ohio & Southwestern R. R., a distance of 24 miles, will be begun in February, 1892, and contracts will be let shortly after. The work will be light and the grades and curves easy. Thos. J. Smith is President.

Eastern, Barnwell & Western.—This company, which was chartered in 1889 to build a railway from Charleston, S. C., through Colleton, Barnwell and Aiken counties to some point on the Savannah River between Hamburg and Brown's Landing, is securing rights of way along the proposed route and has petitioned the city council of Charleston for a donation of right of way on certain streets. Alfred Aldrich, of Barnwell, is President.

NORTHWEST.—Existing Roads.

Milwaukee, Menominee Falls & Western.—This company contemplates building an extension of its line northwest to Beaver Dam, Wis., and possibly to Montello, Wis., the coming season. The towns along the line are being asked for assistance.

Great Northern.—The engineers of this company have located a 19-mile extension of the Wadena & Park Rapids branch from Park Rapids north toward Leech Lake. It is stated that work will be commenced this coming season.

Chicago & Eastern Illinois.—The extension of this road from Tuscola to Shelbyville, Ill., 40 miles, has been completed.

Chicago, Milwaukee & St. Paul.—It is reported that surveys will soon begin for an extension from Mankato to Farmington, Ill.

Projects and Surveys.

Atik Okan Iron Range.—W. W. Russell, of Port Arthur, Ont., who made the surveys for this proposed railway, is reported as saying that there was but little doubt that the line would be built during the coming summer. It is to run from a point on the Canadian Pacific Ry. near Carlstadt to the Atik Okan Iron Range.

Quincy, Keokuk & Chicago.—The right of way for this line from Quincy to Niota, Ill., has been nearly all secured and considerable local aid obtained. The company is now engaged in securing subscriptions to its capital stock. It agrees to have its line completed by Dec. 31 1892.

SOUTHWEST.—Existing Roads.

Stuttgart & Arkansas River.—It is stated that this company has begun work on an extension from De Witt to Pendleton, Ark., 20 miles.

Chicago, Burlington & Quincy.—This company is surveying a line from Bogard, Carroll, Co., Mo., to a connection with the Hannibal & St. Joseph R. R. in Clay Co.

Red River & Southwestern.—A press dispatch states that a contract to complete and equip this railway from Henrietta to Archer City, Tex., 30 miles, has been made with the Union Trust Co., of New York City. The road is to be completed and in operation by March 1, 1892.

Missouri Pacific.—Tracklaying on the Houston, Central Arkansas & Northern R. R. has reached a point 20 miles south of Columbia, La., and is progressing at the rate of 2 miles per day. It is expected to have the road completed to Alexandria, La., by Jan. 1, 1892.

Chicago, Rock Island & Pacific.—T. H. Peters, Locating Engineer, left Topeka, Kan., Nov. 24, with a corps

of engineers, for Minco, Ind. Ter., to run preliminary surveys south from that point to the Gulf of Mexico.

Projects and Surveys.

American Construction Co.—This company has been chartered at Hutchinson, Kan., to build railways and telegraph lines.

Ft. Worth & Trinity Valley.—Chartered in Texas to build a railway from Ft. Worth, Tex., to the north boundary of the State in Clay Co. Among the incorporators are: Chas. J. Lorimer, Ft. Worth, Tex., and S. S. Brown, St. Joseph, Mo. The principal office will be at Ft. Worth, Tex.

Madison & St. Clair Belt.—A press dispatch from Alton, Ill., says:

The preliminary arrangements for the granting of the franchise to the Madison & St. Clair Belt R. R. to the land in front of the city for the Union Depot and shops are being completed as fast as possible. On Nov. 20 Geo. S. Morrison, Consulting Engineer of the C., B. & Q. R. R., and Edward Whittaker, of the firm of Whittaker & Hodgman, financial agents of the road, were here in consultation with the city officials, and agreed on the ordinance to be presented to the City Council. These gentlemen stated that work on the contemplated bridge over the Mississippi here would be started as soon as the company received the franchise, and that the bridge here would be built before the one over the Missouri River. It is still believed that the Burlington folks are behind the whole movement.

DeKalb & Red River.—Chartered in Texas to build a railway from DeKalb to Red River, Tex. Among the incorporators are: Wm. Peters, and C. A. Skinner, of DeKalk, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—Shepard, Henry & Co. are reported to have the contract for building the mountain division of the Pacific extension from the Puget Sound east along the Snohomish River. This leaves only about 225 miles of the line to be put under contract in Washington. The line between Pacific Junction, Mont., and Chatteroy, Wash., about 500 miles is being rapidly pushed. About 250 miles have been completed, and the remainder is under construction. Tracklaying is reported to be progressing at the rate of 50 miles per month, and according to reports in the Washington papers will be finished to at Sand Point, Idaho, by the end of the year. Connection has been made with the Northern Pacific Sand Point, and track is being laid from that place east as well as from Pacific Junction west. The route of the line across Washington has not been made public yet, but the most probable route, in a general way, seems to be from Spokane down the Moses Coulee and up the Columbia River, to the mouth of the Wenatchee River, where the Columbia will be crossed, thence up the Wenatchee and across the mountains at Stevens Pass, and thence along the Skykomish River to the Snohomish River to a connection with the line east along that stream. The annual report of the company for the year ending June 30, 1891, contains the following in regard to the character of the work:

Tracklaying on the Pacific extension has been nearly completed to the summit of the Rocky Mountains. During the winter a large force was employed on the heavy work between the summit of the main range and Spokane Falls, and this force is being largely increased for the summer's work, with the intention of completing, as far as possible, before next winter, the grading to the I st-named place. Careful and thorough examination has been made of the entire country along the line of the Pacific extension, through to Puget Sound, resulting in a line shorter and with lower grades than those of any trans-Continental line heretofore built between the Great Lakes and the Pacific Ocean. The work on this line, including the roadbed and bridges, is being done in the most substantial and thorough manner, to provide for using the heaviest types of locomotives and cars with the greatest safety. It is expected that the line will be completed to the Pacific coast in time for the summer business of 1893.

Northern Pacific.—It is reported that construction will soon begin on the projected line from Kootenai, Idaho, north into the Kootenai Valley.

Seven Devils.—According to the *Helena Mining Journal* a contract has been filed in the office of the Salt Lake Co. Recorder by which Thos. W. Bates, of Salt Lake City, Utah, agrees to build a railway from a point on the Oregon Short Line to a point near the Blue Jacket mine in the Seven Devils mining district in Idaho. According to the contract work is to be begun before May 1, 1892, and 50 miles of the road completed by Jan. 1, 1893.

Projects and Surveys.

Puget Sound, Lake Washington & Eastern.—This company has been chartered in Washington to build a railway from Edmonds, Wash., east to a point in the eastern part of Washington near Spokane.

Seattle, Boise City & Salt Lake.—At the annual meeting of the stockholders of this company in Payette, Ida., on Nov. 6, the following directors were elected for the ensuing year: Thomas W. Bates, A. B. Moss, M. L. Sproat and J. H. Richards, of Payette, Ida.; Martin Patric, Blackfoot, Ida.; Joseph Pinkham, Boise City, Ida. And at the meeting of the directors the following officers were elected: Thomas W. Bates, President; A. B. Moss, Vice-President; M. L. Sproat, Secretary; Joseph Pinkham, Treasurer.

FOREIGN.

Monterey & Mexican Gulf.—It is stated that this company will arrange for the early construction of its proposed extension form Trevino, formerly Venadito' Mex., west into the Sierra Mojada.

Africa.—The Railways Committee of the French Chamber of Deputies has approved a bill to extend the railways in Southern Algeria to Tunis. It is believed that this railway extension will furnish effective means to subdue the tribes harassing the frontier.

CITY TRANSIT.

Electric Railways.—*New Haven, Conn.*—There is talk of constructing an electric railway from New Haven to Allington, Conn. It is stated that the electric conduit system will be used.

Norwich, Conn.—The Norwich St. Ry. Co. will petition the Common Council for power to adopt electricity as motive power on its lines. The trolley system will be used.

Bellefonte, Pa.—The Bellefonte St. Electric Ry. Co. has been chartered to operate a street railway at this place. Louis E. Reber, President.

Bucyrus, O.—The Bucyrus & Galion Electric Ry Co, has begun surveys for its proposed line.

Monmouth, Ill.—An electric railway is to be built at this place.

Sacramento, Cal.—The Central St. Ry. Co. has petitioned for a franchise to build an electric line from J St. ts 28th St. Address J. H. Henry.

San Bernardino, Cal.—An effort is being made to organize a company to build an electric railway from this place to Ontario.

Santa Fe, N. Mex.—A franchise has been granted to the Santo Fe Electric Co., authorizing it to extend its electric light lines to all parts of the city and to build an electric street car system.

Ouray, Colo.—The Ouray & Ironton Electric Ry. Light & Power Co., has been organized to build an electric railway from Ouray to Ironton, Colo. Otto Mears, Denver, Colo.

Elevated Railways—*Chicago, Ill.*—The West Side Rapid Transit Co. has been chartered with a capital stock of $2,000,000. It is proposed to construct an elevated railway on Lake, Randolph, Madison, Van Buren, Harrison, Twelfth and Twenty-second streets, from a point as near Lake Michigan as practicable, and extending westward the entire length of said streets, in the city of Chicago. Lines are also projected on Milwaukee, Blue Island and Archer avenues, on Halsted St., and such other parallel and cross streets as looping or connection of its lines may render necessary. The incorporators are Oscar W. Rogers, K. L. Baldwin and G. M. Miller.

Motor Roads—*Portland, Ore.*—The Portland & Hillsboro R. R. Co. has been chartered to build a motor road from Portland to Hillsboro, Ore., 21 miles. Eugene D. White, Richard Morton, Portland, Ore.

Street Railways—*Omaha, Neb.*—The Omaha & Florence St. Ry. Co. has been chartered to build a street railway at this place.

HIGHWAYS.

Pennsylvania.—The Plymouth & Wilkesbarre Turnpike Co., of Wilkesbarre, Pa., has been chartered to build a turnpike in Luzerne Co.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Corinth, N. Y.*—The Saratoga County Supervisors have authorized the construction of a bridge across the Hudson River at this point. The structure will cost about $18,000.

Milwaukee, Wis.—The proposed Menominee viaduct will run from Sixteenth St. to Pierce St., 4,000 ft., and is estimated to cost $450,000. The roadway will be 40 ft. wide, with 10-ft. sidewalks on each side. There will be a swing span across the Menominee River.

WATER-WORKS.

NEW ENGLAND.

Boscawen & Penacook, N. H.—Bids for constructing works will soon be asked by the committee. Estimated cost, $80,000.

Lancaster, N. H.—The survey for the proposed new works has been completed by E. H. Gowan, Boston. Construction will not be started until spring, although some of the contracts may be let at once. Address Lancaster Water Co.

Bellows Falls, Vt.—A special meeting will be held Dec. 9 to consider proposed improvements.

West Randolph, Vt.—There is talk of another reservoir in connection with the village works.

Clinton, Mass.—The town has voted to petition the Legislature for authority to take water from Waushacum Lake for a new supply.

Fitchburg, Mass.—The Council has voted to petition the legisiature for authority to take water from Wachusett Lake in Princeton, Meeting House Pond and Wyman's Reservoir in Westminster. The petition will include provision for a compensating reservoir to make good any damage that would otherwise result to mill-owners. Authority to issue $300,000 of 4½ 30-year bonds to cover the expense of the above improvements will also be sought.

Hanover, Mass.—The Hanover Water Co. proposes to build works.

Millbury, Mass.—C. D. Morse, W. H. Lincoln and others have applied for a charter for a water company.

Newton, Mass.—About 2,000 ft. of mains will be laid, at an estimated cost of $4,700.

Providence, R. I.—Bids for 1,196 long tons of 4 to 12-in. cast iron pipe are wanted until Dec. 15, by Robert E. Smith, Commissioner Public Works.

East Hartford, Conn.—It is reported that arrangements are to be made for the construction of works, probably by the East Hartford Water Co.

Bridgeport, Conn.—A 10,000,000-gall Worthington pump has been contracted for.

South Norwalk, Conn.—Petitions are being circulated by Finkenstein & Kelley, proprietors of Roton Point, asking the city to extend the mains through that village.

MIDDLE.

Clifton Springs, N. Y.—It is estimated that a supply can be obtained from a spring at a cost of $20,000. The people have recommended that the trustees correspond with one or more companies regarding the building of works.

Warsaw, N. Y.—Municipal ownership is talked of.

Highland Park, N. J.—A supply from the New Brunswick works is talked of.

Irvington, N. J.—The trustees have informed Newark that they wish a supply from that city if it can be obtained at a reasonable rate.

Jersey City, N. J.—It is rumored that a new supply may be obtained from the East Jersey Water Co., which is just completing works for Newark's new supply.

Carbondale, Pa.—The Fall Brook & Newton Water Co. has been incorporated; capital stock, $10,000; directors, A. H. Vandling and C. S. Weston, Scranton; C. Rollin, Manville; W. Bowers and J. E. Been, Carbondale.

Fairchance, Pa.—Works are projected with a supply from mountain springs. Estimated cost, $15,000.

Martinsburg, Pa.—A preliminary survey for works shows the spring from which it is proposed to take the supply to be 187 ft. above the town; also that four miles of supply and distributing mains will be needed.

Mifflentown and Patterson, Pa.—A supply from Macedonia Run for these towns is projected. Address F. H. Gilbert, Millersburg.

Philadelphia, Pa.—An item of $2,535,639 for extensions, including new pumps, boilers, and the Roxborough reservoir, is reported as passed in the appropriation bill.

Somerset, Pa.—The water works election, referred to last week, will be held Dec. 19.

Stockton (Suburb of Camden, N. J.).—A preliminary contract has been signed granting a franchise to a company to supply settlements in Stockton Township. The people will vote on the question Dec. 15. Seven miles of mains and 60 hydrants are proposed.

Cumberland, Md.—A filtering plant is talked of.

SOUTHERN.

Macon, Ga.—A new contract has been executed between the city and company by which the latter agrees to increase the daily capacity of the plant to 5 000,000 galls., to increase the capacity of the mains and to add or extend a filtering plant, all to be done by January, 1893. This contract, later reports state, is conditioned upon the failure of the people to vote funds for city works on Jan. 20 next.

Milledgeville, Ga.—It is reported that the American Pipe Manufacturing Co., Philadelphia, has received a 30-yrs. franchise and contract to put in works with 75 hydrants at a yearly rental of $3,200. Works have just been built by S. Walker, and it is stated that the new company has secured an option to purchase them. Construction must be started within three months and completed within eighteen months.

Anthony, Fla.—A supply from Dr. Kendrick's artesian well is talked of.

Birmingham, Ala.—J. T. Fanning, Minneapolis, Minn., has been engaged by the company as Consulting Engineer.

Natchez, Miss.—The works of the Natchez Water & Sewer Co. have been bought at a foreclosure sale by James S. Richardson, New Orleans, for liabilities and $19,000. The full amount of claims is said to be $154,000. A new company will probably be organized.

Mansfield, La.—Works, including an 80,000-gall. elevated tank, are projected.

Plaquemine, La.—It is reported that a contract for constructing works has been awarded to W. L. Covell, Biloxi, Miss., for $15,000.

Lawrenceburg, Tenn.—It is reported that C. W. Kirby and R. H. Harvey have contracted to build works here.

Cloverport, Ky.—A proposition has been made by a Philadelphia syndicate to build $60,000 works.

NORTH CENTRAL.

Hammond, Ind.—The contract for constructing the new works has been awarded to Remington & Co., Chicago. Contract price, $89,922.35. C. McLennan, Chicago, is the Consulting Engineer.

Collinsville, Ill.—Water said to be fair in quality has been struck at 605 ft.

Mowequa, Ill.—The people have voted for works.

Menasha and Neenah, Wis.—Works are proposed

but it is stated that definite action will not be taken until next spring.

NORTHWESTERN.

Clinton, Ia.—A 5,000,000 Gaskill pump has been contracted for.

Glenwood, Ia.—The citizens are urging the Board of Trade to take immediate action regarding proposed works.

West Duluth, Minn.—The company has received permission to build a reservoir and provide a high and low service.

Dillon, Mont.—J. F. Cowan, Butte, has applied for a water and electric lighting franchise. The supply, as proposed, will be conveyed from Beaverhead River to a 150-HP. turbine wheel, which would pump water and run the dynamos.

SOUTHWESTERN.

Excelsior Springs, Mo.—The construction of works has just been started by a company. Estimated cost, $25,000.

Hannibal, Mo.—Plans for a new reservoir have been made.

Kansas City, Mo.—Preliminary steps for the construction of the proposed city works have been taken, an ordinance having been passed providing for a chief engineer and superintendent of construction.

Neosho, Mo.—The Neosho City Water-Works Co. has been incorporated; capital stock, $50,000.

Dublin, Tex.—The Dublin Water-Works Co. has let a contract for the construction of works to the Southern Improvement Co., Dallas. Cost, about $25,000.

Galveston, Tex.—Good water has been struck at 800 ft. in the 3-in. test well.

Quonah, Tex.—A press dispatch states that a company to build water, electric lighting and ice plants, is wanted.

Santa Ana, Tex.—Incorporation as a town is proposed to prepare the way for building works.

Rockdale, Colo.—It is reported that surveys for works are being made, $18,000 having been voted for works.

South Denver, Colo.—An extension of two miles of mains is proposed.

PACIFIC.

Colfax, Wash.—Bids will be received until Dec. 17 for about 5 miles 10 to 4-in. pipe, 46 hydrants, a 500,000-gall. reservoir, supply well and receiving basin, and 1,000,000-gall. pumping plant. Address L. T. Bragg, Chairman Committee on Fire and Water.

Columbia, Wash.—The company proposes to to put in additional and larger mains.

Kent, Wash.—Plans and specifications for works have been prepared by Engineer Shepard, Seattle, and accepted by the Council. Estimated cost, $15,000.

Pasadena, Cal.—The purchase by the city of the works of the several companies is talked of, as is also the organization of a new company to absorb the old ones.

San Bernardino, Cal.—Extensions to the mines are proposed.

Ukiah, Cal.—Trustees Hagans, Brown and Gibson have been appointed as a committee to ascertain the best means of supplying the town with water.

Payson, Utah.—Works are talked of.

CANADA.

Toronto, Ont.—The Gravitation Committee of the City Council has recommended the appropriation of $12,000 for the purpose of investigating the feasibility of a gravity supply from Lake Simcoe.

ARTESIAN WELLS.

Danville, Ky.—A well is being built by the Danville Ice Co. which, it is thought, may develop a supply sufficient for the whole town.

Freeburg, Ill.—Bids for sinking a well are wanted by City Clerk Z. T. Hanna.

Monmouth, Ill.—R. G. Young, Superintendent of water-works, informs us that an increase of water supply is projected, and that correspondence with deep-well contractors is desired.

Bonham, Tex.—It is reported that the Council has contracted with Herdegan & Schney, New York, for a daily supply of 300,000 galls. of water from one to five wells, the price to include sinking and casing the wells and furnishing the pump. The supply must be developed within five months.

Denison, Tex.—It is reported that 50 wells will be sunk here.

Lufkin, Tex.—Capital to sink a well has been secured. Address B. F. Bonner.

Whitewright, Tex.—Preparations for the sinking of two artesian wells to supply the town with water are reported.

Caldwell, Idaho.—The experimental well having proved a success it is reported that several wells will probably be sunk in the town.

IRRIGATION.

Colorado.—John S. Titcomb, Deputy State Engineer, informs us that the state has let a contract for the "Apishopa Creek Reservoir" to J. R. DeRemer & Co. for $13,993. The bid of the Western Construction Co. was $19,000.

Ellensburg, Wash.—The contract for building the Middle Irrigating Ditch has been awarded to the Burlingame Contract Co., Tacoma, for $200,000 in 6s 20-year bonds. Work will be started at once. The ditch will be about 20 miles long.

Acton, Cal.—The Soledad Storage, Dam & Reservoir Co., of Los Angeles, it is stated, propose to build a dam in the Aliso Cañon, three miles from Acton, which will be 150 ft. high, 800 to 900 ft. long, and will impound 8,000,000,000 galls. of water.

Riverside, Colo.—The Riverside Trust Co. has let a contract for cementing six miles of the Gage Canal. Matthew Gage is General Manager of the company.

New Companies.—Fremont Ditch, Pipe Line & Reservoir Co., Colorado Springs, Colo.; $100,000; incorporators J. C. Plumb, S. H. Kinsley and others, owners of Fremont townsite at Cripple Creek. Hood River Flume & Power Co., Hood River, Ore.; $20,000. Eagle Valley Irrigation Co., La Grande, Ore.; $5,000; C. M. Donaldson and others. Tomalow Irrigation Co., Prineville, Ore.; $4,000. Poplar Irrigation Co., Poplar, Cal.; $41,000. City Heights Land & Water Co., San Diego, Cal.; $500,000, directors, D. Choats, F. L. Castle and others.

SEWERAGE AND MUNICIPAL.

Sewers.—*Massachusetts.*—Malden. More sewers will soon be constructed.—Wakefield. Dr. J. A. O'Leary, Wm. G. Strong, Dr. S. W. Abbott, Thomas J. Skinner and George W. Harrington have been chosen as a committee to look into the subject of sewerage for the town and report at the March meeting.——Winthrop. At a town meeting recently held the matter of sewers for the section of the town not accommodated by the present system was discussed, and committee chosen, consisting of David Floyd, Jr., H. A. Root and Captain W. B. Floyd to employ an engineer and get estimates and plans for a complete system for the town. Five hundred dollars was appropriated for preliminary work, and $2,000 was voted to pay land damages and for the construction of the extension of Winthrop St. to the Cherry St. station.——Westfield. Nearly 11 miles of sewers have been constructed during the last three years. It is hoped to complete the system next year.

Connecticut.—Meriden. The city has bought 20 acres at Falls Plains for sewerage purposes.

Rhode Island.—Bristol. A sewer from Bifield St. through Milk and up Church, to the corner of High St., is started. A good part of the town is now provided with sewerage, and all done by private enterprise.

New York.—Far Rockaway. For 3 years the authorities have tried to perfect a plan for the sewerage system, and the last one presented has been rejected by the State Board of Health. The objection to the numerous proposed systems has been the location of the outlet into Jamaica Bay. It is now suggested that pipe lines be constructed 2 miles out into the bay, which would entail a great expense.——Lansingsburg. It was expected the sewer construction by the Troy Public Works Company would commence the first of the month, and the work is to be finished by October of next year.—Norwich. A petition for a sewer commission has been presented to the Board of Trustees.——Port Richmond. A meeting will be held to discuss the introduction of a general sewerage system.——Saugerties. It is said that a good system of sewerage is becoming an absolute necessity, and the organization of an improvement company is being agitated.

New Jersey.—Orange. All bids for the outlet sewer have been rejected. The committee is directed to prepare new specifications and get new estimates for the work. Action on the ordinances is postponed till Dec. 14.

Pennsylvania.—Philadelphia. The Finance Committee recommends $665,000 for main sewers and $200,000 for branch sewers.

Ohio.—Cincinnati. The sewer in Quebec road was awarded Folz & Jonte at $17,298, and 500 ft. in Moerlein Ave. to Murry & Son at $1,500. The engineers' final estimate for sewers in McLean Ave., Harrison Ave., and Bogen St., is $3,563.23.——Columbus. Bids for the construction of the southeast branch of the Indianola sewers were rejected and the clerk authorized to readvertise. For a long time the city council has been wrestling with the sewage disposal problem. Trips have been made to other cities, and European systems have been diligently studied, but without satisfactory results. The Board of Public Works and other city officials have recently returned from a trip to Pullman and Chicago, and a sewage farm is now being agitated. It is expected that some definite plan will be decided upon in the near future.

Indiana.—Indianapolis. The Board of Works has decided again on a thorough drainage system for the territory northeast of the city, and proposes to do the work early next spring. An open ditch to cost $30,000 and a 4-ft. sewer to cost about $45,000 will be constructed.

Illinois.—Chicago. Measures to stop the pollution of Lake View water supply are provided for by an ordinance providing for "a brick sewer from the city limits on the north and along the lake shore, connecting with and emptying into Fullerton Ave. sewer, and that all of the sewers now emptying into lake between said points be connected with said sewer so constructed."—Freeport. An ordinance will be presented at the next meeting of the City Council for a general sewer system for the city.—Harvey. Contracts for the big sewer have been let to Michael Joyce, of Englewood, at $40,000. There were four other bidders.—Hinsdale. A $20,000-sewer contract has been awarded J. C. Mellon, of Park Ridge.—Morgan Park. Sewer ordinances for $190,000 have recently been passed. Further improvements are contemplated.

Michigan.—Marquette. Profiles for the second section of the trunk sewer and for the new sewer on Prospect St. were presented by the City Engineer and adopted. The Recorder will advertise for bids for the construction of each.—Negaunee. About $20,000 worth of sewers will be constructed.

Minnesota.—St. Paul. The Street Committee recommends $50,000 for the Trout Brook and Phalen Creek sewer.

Texas.—Beaumont. The City Council has contracted with J. S. Thacher, of Dallas, for $650, to make surveys and specifications for a system of sewers, after which bids will be asked for construction of the same.—Brenham. Mayor Wilkins has sent a favorable reply to a northern construction company concerning a charter for a system of sewers.

California.—Alameda. A sewer is talked of in Sherman St. and thence to Parn St.——Los Angeles. The City Engineer was instructed to suspend all engineering work and at once complete the survey of the outfall sewer and laterals.—Oakland. Several streets will be sewered.——San Bruno. The Road Improvement Club has asked the Board of Health to change the sewers on some of the parallel streets.——San Francisco. The Superintendent of Streets recommends that sewers be constructed in 4 streets.

Ontario.—Toronto. During the last trunk sewer discussion it was shown that a low level sewer on Front St., which would answer the purpose for 10 years, would cost about $500,000, and a high level sewer would cost about $800,000 additional. The construction of said sewer was declared everything from an absolute necessity to the most wanton waste of public money.

Streets.—*Massachusetts.*—Boston. At the last meeting of the Board of Aldermen the Street Commissioners reported estimates of street improvements amounting to $117,000. An order requesting the Park Commissioners to take by purchase or otherwise, for park purposes, a parcel of land containing 59,470 square feet and bounded by Harrison Ave., Reed, Hunneman and Thorndike streets was assigned to the next meeting.

New York.—Mount Vernon. The streets are being greatly improved. A foundation of large stone is covered with a top dressing of macadam, which is afterward rolled until smooth.——Troy. Brunswick Ave., will be graded by J. H. Cavanagh, for $1,130, work to be done in 10 days.

Pennsylvania.—Carlisle. A number of streets are being opened.——Philadelphia. Chief Smedley, of the Bureau of Surveys, has been busy for several days preparing estimates for boulevards, as requested by Councils. The Finance Committee recommends items for street improvements amounting to $1,195,000.

New Jersey.—Cape May. A movement for paving the streets has been started.

Maryland.—Baltimore. Mayor Latrobe favors applying to the Legislature for an enabling act for a new loan of $5,000,000, of which $2,000,000 might be devoted to improved paving and $1,000,000 for additional sewers or other necessary internal improvements.

Ohio.—Cincinnati. The engineer reported bids for the improvement of Gilbert Ave., from Court St. to 1,027 ft. north, as follows: J. McDermott, $37,720; J. Donovan, $39,330; J. Regan, $37,615; J. A. Eberhart, $37,640; Kirchner & Scully, $37,715; also, for improvement of same street on to park entrance: J. Regan, $95,411.25; J. McDermott, $95,668.25; Kirchner & Scully, $99,450; J. A. Eberhart, $95,530; J. Donovan, $95,552.50. In both instances contracts were laid over for future consideration. Bids for Sassafras St., from Colerain Ave. to Marine St.: Leonard & Fay, $6,516. T. J. Peter, $6,267.65; J. McDermott, $5,952.05. Awarded to Mr. McDermott. The final estimate for Faike St. improvement, from Molitor to St. Clair is $10,755.99; and for the improvement of Alfred St. with bowlders, from Spring Grove Ave. to Colerain Ave., $5,170.06.—Cleveland. A system of parks and boulevards is being agitated. Columbus. The Board of Public Works will extend several streets. McCloud and Geigel have the contract to improve Green Lawn Ave. and Wall St., and N. B. Abbott, Chapel St. John Keller will grade the roadway of Doyle St., at 60 cts. per cu. yd.—Massillon. $50,000 will be spent in improving streets.

Illinois.—Chicago. Specifications have been made by the West Park Board for paving with granite macadam the Central driveway through several boulevards of the West Side; 21,144 cu. yds. of crushed granite will be required, and the estimated cost is $307,163. The attorney will draw up a contract.——Piasa. The directors of the Piasa Bluffs Improvement Co. intend to expend $100,000 within the next two years improving its grounds at Piasa Bluffs.

Louisiana.—New Orleans. The estimates of the Commissioner of Public Works for 1892 amount to $402,500.

Texas.—Galveston. The Board of Aldermen has voted to pave 40 blocks. The City Attorney deems the paving of 80 blocks at the present time entirely practicable.

Missouri.—East St. Louis. City Engineer Weber is making a survey of Broadway preparatory to paving it with granite blocks. The cost is estimated at $40 per lin. ft., and the amount of work to be done will cost $60,000.

Nebraska.—Omaha. For grading Ames Ave. from Sherman Ave. to the city limits east, Callahan & Craft bid 29.9 cts. per cu. yd., with an overhaul of ¼ mile. The board considered this too high and will readvertise.

California.—Alameda. Three streets will be macadamized.——Los Angeles. Union Ave. will be graded, graveled and curbed from Sixth to Hoover, and Fifth St. paved from Main to San Pedro Sts. with bituminous lime rock and porphyry base. J. T. Davis will grade and curb a portion of Wilde and Sixth Sts. at $1.30 per lin. ft.——San Francisco. The Superintendent of Streets recommends that bituminous pavements be laid on 8 streets.

Montana.—Helena. The City Council is petitioned to grade Broadway. The estimated cost, exclusive of relaying water, gas or sewer pipes, is $21,406.50.

Washington.—Seattle. Ten bids for the improvement of Farm St. were received. The contract was awarded to S. M. Rice & Co. at $2,022.32.

Quebec.—Montreal. The Board of Chairmen has appropriated $75,000 for an open subway and upper level roadway in Berri St. The city will also expend $10,000 in grading and macadamizing Atlantic Ave., any additional cost to be defrayed by the different municipalities. The macadam is to be 50 ft. wide, and the sidewalks 12 ft.

Bonds.—Norwood, O.; $4,717.80 for improvement of Mentor Ave., at 6%; bids received till Dec. 23; W. E. Wichgar, Village Clerk.——Avondale, O.; $25,000 for street improvements, at 4%, bids received till Dec. 14; W. Ellwood Wynne, Clerk ——Boston, Mass.; $200,000 for construction of Commonwealth Ave., at 4%, and $160,000 for the construction of the L St. bridge.

ELECTRICAL.

Electric Light.—***Goffstown, N. H.***—Electric lighting is being discussed.

Chicopee, Mass.—The aldermen recommended that the city purchase and maintain its own plant.

Pascoag, R. I.—A complete system is being constructed. Two sets of wires are being put up, the direct current to be used in connection with the Ball arc lamp for street lighting and the alternating system for the incandescent lights. It is suggested that this plant be also used to light Harrisville.

Quakertown, Pa.—Bonds will be issued for $15,000 to erect a plant.

Wheeling, W. Va.—The Electric Light Commission has rejected the ordinance presented by the Edison Electric Light Co. and has asked the Council to instruct the City Solicitor to ascertain, with a view to purchasing, the probable cost of the equipment and appliances used in manufacturing incandescent light by the Wheeling Electrical Co.

Bryson City, N. C.—A plant will soon be erected.

Sutherland, Fla.—Electric lighting is proposed.

Cleves, O.—There is talk of building an electric light plant to light the adjoining villages of Delhi, Home City, Fernbank, Addyston, North Bend and Cleves. In order to inquire into the cost of such a plant and the advisability of its construction, Councilman W. R. Funk has been appointed from Cleves to meet committeemen from the other villages.

Hamilton, O.—It is claimed that a majority of the people favor establishing an electric light plant, both arc and incandescent, for public and private lighting.

Zanesville, O.—A co-operative electric light company has been formed with a view of securing lighting at first cost.

Peru, Ind.—The City Clerk desires bids until Dec. 8 for furnishing and maintaining 50 or more arc lights, the contract to take effect June 1, 1892.

Terre Haute, Ind.—The Council has rejected the bid of $75, and will doubtless readvertise. The Council has been inspecting other plants, and it is thought would like to purchase one for the city.

Tipton, Ind.—A. S. Nickey is to furnish 15 Thomson-Houston lights at $70 per light per year.

Chicago, Ill.—The South Park Commissioners propose a plant to run 300 lights.

Farmington, Ill.—A contract has been awarded for 55 32-c. p. lights for 20 years.

La Grange, Ill.—A Citizens' Electric Co. has been formed with a capital of $25,000.

Detroit, Minn.—Electric lights will be erected.

Waseca, Minn.—Electric lighting is expected early next year.

Fowlerville, Mich.—A plant will be put in and $700 per year expended in its maintenance.

Ypsilanti, Mich.—An electric company has been organized with $25,000 capital stock to supply light and power.

Grand Island, Neb.—Incandescent lights will be put in.

Healdsburg, Cal.—A plant to cost $12,000 is contemplated by eastern capitalists.

Independence, Ore.—A franchise has been granted and a plant will soon be put in.

Waterville, Wash.—Electric lighting is expected soon.

Guelph, Ont.—A contract has been made for 5 years with the Guelph Gas & Electric Light Co. for 75 lights at 24½ cts. per night.

Carleton, N. B.—A 2,000-c. p. dynamo has been ordered and a new brick light station is being built.

Moncton, N. B.—New electric light works will be constructed. Local capitalists are interested, and Toronto parties have been here negotiating in reference to the supply of the plant.

New Companies.——The Des Moines Water Power & Electric Co., Des Moines, Ia.; L. W. Goods, Fred. D. Goods and C. E. Meade; $225,000.—The Eldredge Electric Co., Bloomfield, N. J.; to manufacture and sell electrical and other inventions of Rolfe Eldredge; Chas. L. Heins, Bloomfield, N. J.; R. Eldredge, New York, and M. C. Kellogg, Mt. Vernon, N. Y.; $100,000.—The Cleveland Electric Light Co., Cleveland, O.; A. L. Bassett, C. E. Shattuck, Charles H. Gill, R. A. Carran, and H. C. Bunts; $100,000.—The International Electric Supply & Construction Co.; Columbus Waterhouse, James Spiers, H. S. Crocker, C. R. Swanberg, C. S. Benedict, A. F. Johns, E. E. Parsons, C. Montgomery and Andrew Brown; $5,000,000.—The Washburn Electric Light & Power Co., Washburn, Wis.; A. C. Prohert, J. F. Meehan and Peter Nelson; $20,000.—Mechanicville Electric Light, Heat & Power Co., Mechanicville, N. Y.; C. R. Sheffer, Stephen Lee, J. H. Packer; $25,000.—Chicago Boulevard Electric Bus Co., Chicago; Harrison R. Meech, Frank B. Meech and Frank Meech; $100,000.—The Ronceverte Electric Co., Ronceverte, W. Va.; Thomas J. Shyock, George F. M. Houck and James E. Brower, all of Baltimore; $100,000.—The Morgan Electric Light & Power Co., Morgantown, W. Va.; H. S. Sands, O. S. McKinney and G. C. Sturgis; $100,000.—Torresdale Electric Light & Power Co., Philadelphia; Edward Morrell, Samuel F. Gillis and James Jordan, Jr.; $1,000.—Safety Electrical Co., Newark, N. J.; August Bromel, Frank Brabson and Richard J. Brittain; $25,000.—Point Pleasant Electric Light & Power Co., Point Pleasant, W. Va.; $50,000.—The Velasco Ice, Light & Refrigerator Co., Velasco, Tex.; making ice and operating electric plant; $50,000.—Railway Electric Lighting & Heating Co., Chicago; lighting and heating railway cars and dealing in electrical and mechanical devices, &c.; $500,000.

CONTRACTING.

Sewer.—***Boise City, Idaho.***—The contract for building the new system of sewers has been awarded to Hobson & Wilkinson, of Ventura, Cal., at $29,700. Only Boise City workmen are to be employed in the construction.

Levee.—***New Orleans, La.***—The State Board of Engineers has opened the following bids:

Lauderdale, St. James Parish, 4,500 cu. yds., P. Burns, 18¾ cts.; S. B. Burbank, 22 cts., and P. Harman, 24½ cts. The bid of 18¾ cts. was recommended for acceptance.

Corinne, St. Bernard, 30,000 cu. yds., James Parker, 26 cts.; P. Burns, 30 cts. Both bids were rejected, being considered too high. This is the fourth time that bids on this levee have been rejected, and the levee will not be built this year.

Pavement.—***Chicago, Ill.***—The contract for 74,600 sq. ft. of cement sidewalk in Garfield Park was awarded Schillinger Brothers at 15 cts. per sq. ft.

Viaduct.—***Duluth, Minn.***—The Board of Public Works has awarded the contract for the viaduct over the tracks on Lake Ave. for $68,346.50.

Bridge.—***Philadelphia, Pa.***—The following bids were opened Dec. 1 for the completion of the Walnut St. bridge: Keystone Bridge Co., to be completed in 8 months, $137,700; J. H. Hathaway & Co., in 5 months, $111,557; Edge Moor Bridge Works, in 9 months, $101,440; Levering & Garrigans, in 8 months, $101,940; Phœnix Bridge Co., in 4 months, $99,350; Pittsburg Bridge Co., in 6 months, $94,750; A. & P. Roberts Co., in 6 months, $92,882.

PROPOSALS OPEN.

Blue Island, Ill.—Several short sewers.—Fred. Hohman, Village Clerk, Dec. 7.

Hot Springs, Ark.—Sewers, masonry and street grading of Improvement District No. 11. J. P. Durham, Dec. 8.

Sewer.—***Terre Haute, Ind.***—Pipe sewer on Mulberry St. Chas. H. Goodwin, City Clerk, Dec. 15.

Paving.—***Terre Haute, Ind.***—Paving and curbing on 2 streets. Chas. H. Goodwin, City Clerk. Dec. 14.

Street Work.—***Madisonville, O.***—Grading and macadamizing, including walks, curbs, gutters and drains; Columbia Ave. James Giffin, Village Clerk. Dec. 19.

Granite Blocks.—***Cambridge, Mass.***—About 300,000 granite paving blocks. William E. Doyle, City Hall. Dec. 10.

Cut Granite.—***Washington, D. C.***—The cut granite for the platform stones of the balconies of the pavilions of the building for the library of Congress. B. R. Green, Superintendent and Engineer. Dec. 10.

Electric Light.—***Winnipeg, Manitoba.***—The committee recommend that a rate per light per night be asked for, for not less than 100 lights, also for each additional light over 100, the street plant only to be subject to be taken over by the city, at a valuation, at any time during the contract, and the contract terminated upon the city giving 12 months' notice, the tenders to be received up to Dec. 22.

The advertised time for receiving tenders for the construction of the proposed Assiniboine water power has expired, and no tenders have been received.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Rogers Locomotive Works, of Paterson, N. J., are building 20 10-wheel engines, with 19 in. × 24-in. cylinders, for the Chicago, Burlington & Quincy. The Cooke Locomotive Works, of Paterson, N. J., are building 10 10-wheel engines for the International & Great Northern. The Baldwin Locomotive Works, of Philadelphia, has an order for 21 compound engines for the Philadelphia & Reading; 20 of which will be freight engines. The other is a special engine for fast passenger traffic. The drivers will be 6ft. 6 ins., and the engine has many new devices. It is to be completed Jan. 1, and is expected to beat the record.

Cars.—The Chicago, Rock Island and Pacific is about to buy 40 new passenger cars. The Chicago, Burlington and Quincy desires 30 passenger cars with the Hale & Kilburn seat. The Lehigh Valley will soon order 500 box cars and 2,000 gondolas. The Cleveland, Cincinnati, Chicago & St. Louis are reported about to buy 1,000 freight cars, 25 caboose cars and 50 passenger cars.

Remington & Co, Chicago, has succeeded the Remington Construction Co. The members of the new firm are Carver Remington and Franklin Remington. The new company will carry on a general contracting business, making a specialty of water-works and railroad work. Their offices are in the Exchange Bldg., Chicago.

New Companies.—Mekarski American Compressed Air Motor Co., North Tarrytown, N. Y.; manufacturing and dealing in compressed air motors, air compressors, &c.; $1,000,000.—The Oklahoma Improvement Co., Chicago; W. O. Cheesman, C. B. Bradley and B. A. L. Thomson; $250,000.—The Thomas Car Coupler Co., Sulphur Springs, Va.; $100,000.—United States Tree and Stump Extracting Co., San Francisco; dealing in patents and privileges, manufacturing machinery for extracting stumps and trees; $15,000,000.—The Standard Safety Heating Co. Chicago; Sidney Adler, Philip Lauth, Jr., and Nicholas Nichols; $500,000.—The Corning Steel Co., Chicago; Charles S. Corning, Frank B. Felt and William O. Johnson; $250,000.—Chicago Press Brick Mill Co., Chicago; A. W. Martin, H. A. Sullivan and Wallace B. Gilbert; $1,500,000.—The Empire Car Coupler Co., Weehawken, N. J.; Walter M. Hoag, F. E. Berger, Wm. G. Wattson, C. W. Bradley, and Frank A. Fox; $100,000.—Denver Consolidated Gas Co., Denver, Col.; George Coppell, New York; Isaac N. Seligman, New York; Ed. O. Wolcott, and F. P. McManus; $15,000,000.—The Finfrock & Veesenmeyer Patent Journal Oiler Co., Chicago; George Finfrock, J. J. Alspeter and George Veesenmeyer; $1,000,000.—The California Gas Engineering & Machine Co., San Francisco; George Burgess, J. J. Armstrong, Seth Mann; $100,000.—Midland Improvement Co., Kansas City, Kan.; R. F. Foster, J. L. Brown, Thomas Irish and R. H. Mayburg; $200,000.—Clymer Paving Co., Philadelphia; Jacob L. Clymer, Lloyd Baily and James G. Conway; $10,000.—San Diego Iron Co., San Diego, Cal.; Chas. J. Eames, of New York, President; Warren Wilson, of New York, Secretary and Treasurer; $1,000,000.—Artificial Granite Paving Co., Philadelphia; Jacob L. Clymer, William H. Tompkins, Chas. P. Tomlinson; $10,000.

Metal Market Prices.—***Rails.***—New York: $30 old rails, $20 to $21 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $23 to $23.50 for iron and $17.50 to $18 for steel. Chicago: $31.50 to $33; old rails, $21.75 to $22 for iron and $14 to $16 for steel.

Track Materials.—New York; steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron, 2 cts. for steel; spikes, 2.15 to 2.25 cts.; track bolts, 2.5 cts. with hexagon nuts.

Pipe.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½ per cent. on black and galvanized butt-welded; 67½ and 55 per cent. on black and galvanized lap-welded. Casing, 55 per cent.

Foundry Pig Iron.—New York: $14. to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

Lead.—New York: 4.2 to 4.3 cts. Chicago: 4.1 to 4.15 cts. St. Louis: 4 to 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 cts.; tees, 2.6 cts.; universal iron mill plates, 2 to 2.05 cts.; sheared steel bridge plates, 2.1 to 2.2 cts.; refined bars, 1.8 to 1.85 cts.; steel plates, 2.05 to 2.1 cts. for tank, 2.15 to 2.2 cts. for shell, 2.35 to 2.4 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.2 cts. for tank, 2.6 to 2.35 cts. for shell, 2.6 cts. for flange.